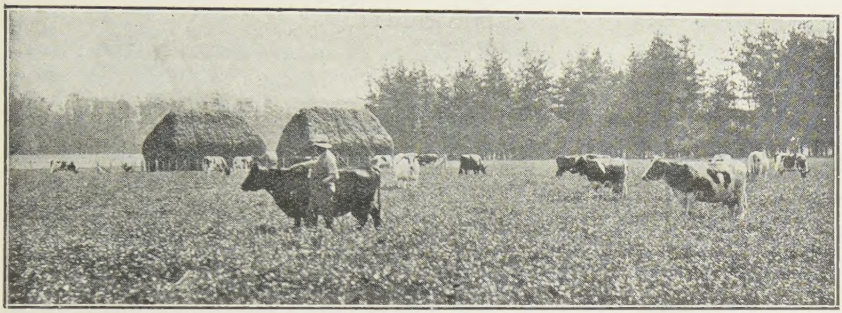

The New Zealand

Journal of Agriculture.

VOL. XXVIII.—No. 6.

WELLINGTON, 20TH JUNE, 1924.

IRRIGATION AND ITS PRACTICE.

(Continued.)

III. METHODS OF APPLYING WATER AND PREPARATION OF THE LAND.

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THERE are three main principles under which the natural moisture content of soil may be artificially supplemented for the improvement of plant-growth. These are (1) sub-irrigation; (2) standing water; (3) surface irrigation. (Fig. 19.)

The first principle is likely to have so little bearing on the purpose of these articles that it will be dismissed with a few brief remarks. The second, though not at all likely to be purposely attempted in Central Otago, has already come about in some measure as the unavoidable result of surface irrigation, and no doubt it will continue to be the inevitable complement of the latter principle. It comes in between the questions of surface irrigation and drainage (with which the writers will deal at a later date), and must therefore be given something more than a transitory place in these discussions. The third principle embodies the vital subject-matter of this series of articles, and will be dealt with by the writers in considerable detail.

SUB-IRRIGATION.

This principle of irrigation consists in adding water to the soil by injecting it at intervals into the subsoil through buried pipes under low pressure. The pipes are either porous or have a series of holes bored in their upper side. Instead of relieving the soil of some of its moisture, as is done by the well-known system of field-tile drains, extra water is introduced into the soil. It has been proved to be fairly efficient, but careful experiments have shown that no other artificial method is as highly productive per unit of water used as surface irrigation. Sub-irrigation would generally prove prohibitive in initial cost, and might only be used in very small plots where the object is the propagation of rare and valuable plants or seed, in connection with which the introduction of foreign plants or weeds, through the medium of water applied to the surface, might render the desired object futile. The principle is sometimes applied to bowling-greens where it is desired to add moisture without even temporarily saturating the surface.

STANDING WATER.

Under every unirrigated piece of land there is a certain depth below which the subsoil is in a state of permanent and complete saturation. In other words, free water lies at this depth in all the interstices, and if a well were sunk into it the water would rest at this level, known as the ground-water level. This level is fixed by the balance which is struck between natural inflow of water to the subsoil from rainfall and the outflow through natural drainage facilities to rivers and lakes. In low river-flats the ground-water level is likely to be sufficiently near the surface to keep the soil and subsoil, within range of the plant-roots, sufficiently moist for vigorous plant-growth. In such cases irrigation would not be required.

In higher terraces the ground-water level is generally too deep under to be of use to plants. It would in some circumstances be possible, but probably not economical, to permanently raise the ground-water the desired amount, by constructing weirs in the river or stream which controls the ground-water level. However, the same effect is frequently brought about quite unintentionally on low areas with inferior subdrainage by the surplus irrigation water which has been applied to higher adjacent areas. This surplus water percolates through the subsoils to the lower areas, giving a greater inflow than their natural drainage facilities can cope with. These lower areas may have been too dry to be of much use in their previous natural condition; but the result may be that the ground-water level is raised permanently (in some parts probably even too high, causing swamps and necessitating expensive drainage), and always in such cases there will be a certain strip of land, between the surface-irrigated area and the area requiring draining, in which the ground-water level has been raised about the necessary height to bring the moisture content in such strip to something approaching ideal requirements. This strip of land is thus benefited under the principle of "standing-water irrigation."

The drainage-works which have to be carried out in respect to the overwetted areas, if scientifically designed and controlled, will lower the ground-water level again by just the correct amount to enable these swamped areas also to be benefited—or, rather, irrigated—under the

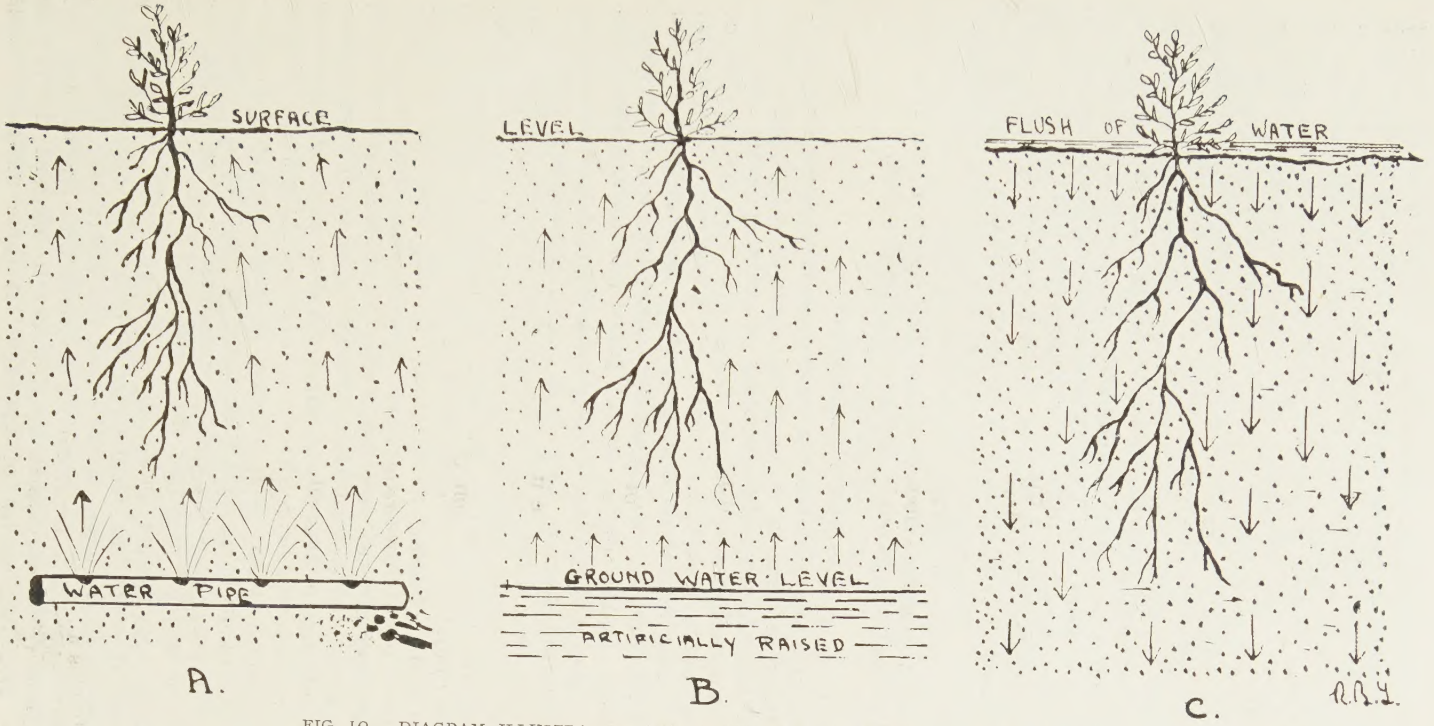

FIG. 19. DIAGRAM ILLUSTRATING THE THREE MAIN PRINCIPLES OF IRRIGATION.

a. Sub-irrigation: Water rising by capillary attraction after occasional injections from buried pipes.
b. Standing water: Water rising continually, entirely by capillary attraction.
c. Surface irrigation: Water passing downward by gravity and capillary attraction during application of flushes to surface. Between flushes it returns upwards by capillary attraction.

[*Original.*

standing-water principle. In this manner a condition of affairs arising out of surface irrigation on the higher lands, which may at first sight appear to be a decided offset to the benefits derived from the irrigation of such higher lands, can, if properly dealt with, be converted into a twofold benefit. Just as it devolves upon the engineer to turn this threatened defect into a blessing with respect to a whole valley-bottom, so, in a smaller measure, can the irrigation farmer benefit by the study and application of the principle of standing-water irrigation, allied with his problems of drainage where such may exist.

Generally in Central Otago the subdrainage is so free that not much benefit can be derived from the principle of standing-water irrigation, but in Ida Valley it is already apparent to a marked degree, and in that locality it is quite obvious that several thousands of acres along the valley-bottom may be reclaimed into first-class land by a system of controlled drainage and regulation of the ground-water level.

Before passing on from this principle of irrigation it should be remembered that, once properly established, it has an advantage over the principle of surface irrigation, by being free from the cost of making and maintaining irrigation-ditches and levelling the land, and from the fact that practically no labour is required in its application.

SURFACE IRRIGATION.

This principle, which is the one more generally practised throughout most irrigation districts of the world, consists of adding moisture to the soil by intermittently spreading or running water over its surface. From centuries of practice it has developed into a distinct branch of agricultural science. It has many variations of application, but before dealing with these it would perhaps be interesting to touch upon the problems which faced mankind, and have to a large degree been solved, in arriving at the present period of advanced knowledge.

In the history of irrigation development the problems of applying water to the land seem to have been fairly satisfactorily solved in respect to the two extremes of conformation—namely, hillsides and almost dead flats—long before any satisfactory methods of dealing with the intermediate gradients were evolved. A reasonable explanation of this can be found in a consideration of the natural association of both these extreme classes of country. In hilly land the frequent divisions of the watersheds by ridges prevents the accumulation of rainfall into anything but very small streams, or, if larger ones exist, they are usually in deep inaccessible gorges. The small streams were easily led round the hillsides in small contour ditches, and, being caused to overflow, trickled readily down the steeper slopes and watered considerable areas before being entirely absorbed by the soil. This method still remains in use under the name of "flooding from contour ditches" (Fig. 20), and is still highly recommended; it is, in fact, the only practical way for irrigating steep slopes.

Where the land below the foothills merges into gently falling plains, as is usually the case, the small streams of water, if discharged from contour ditches as described, would travel too slowly over the surface, and would undoubtedly be found to percolate into and through the subsoil before benefiting large enough areas to warrant the trouble involved. The development of irrigation on these moderate slopes

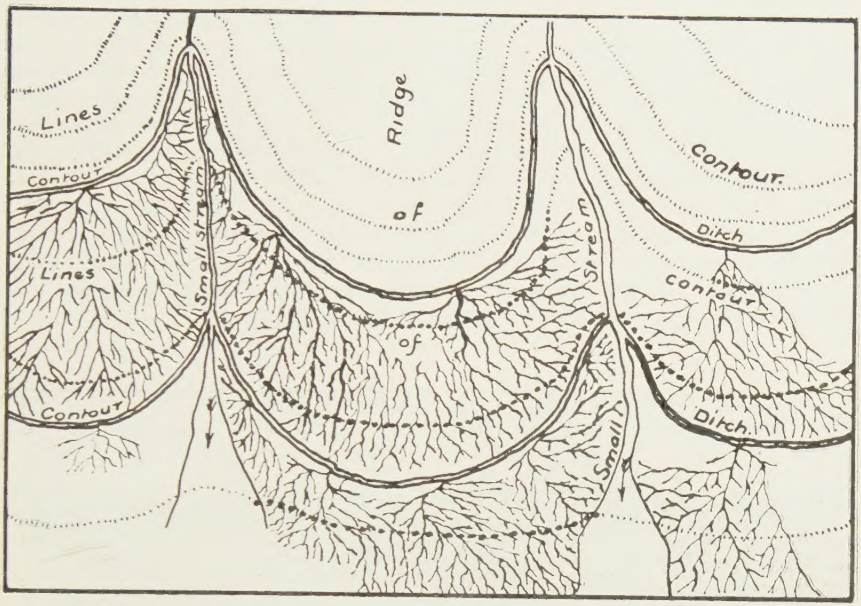

FIG. 20. SKETCH SHOWING PRIMITIVE METHOD OF IRRIGATING STEEP HILLSIDES BY CONTOUR DITCHES FROM ADJACENT SMALL STREAMS.

[*Original.*

was therefore delayed until time and the necessities of increasing populations caused industry and intelligence to be brought to bear on the subject, and, as a result, some of the modern and now most universally adopted methods of application were evolved.

On the other hand, prior to the irrigation of the moderate slopes, and possibly before the irrigation of hillsides, very flat plains were irrigated. Here again is evidence of nature being easily adapted. Very flat plains are generally associated with large sluggish rivers, often requiring very little obstruction to raise them so that waters might readily be diverted on to the flat lands. In such cases vast quantities of water were usually available, and, from their very vastness, would readily spread over huge flat areas without further effort on the part of man. This uncontrolled method is practically what is now known as "wild flooding" (Fig. 21).

But here again any plain with even a very moderate slope was found to give difficulties, in that the large flow of water, if not checked by levees or borders of raised earth and subdivided and spread by specially designed ditches and furrows, would peruse a mad course back to the river, watering only a comparatively narrow strip of land, and as likely as not washing away the soil. Until economical solutions were found for the design and construction of methods of control, the irrigation of these moderate slopes was again delayed, as in the case of irrigation by small streams from contour ditches.

Irrigation practice in Central Otago, with a few exceptions, is not yet very far advanced from the primitive methods referred to. There are very few places where dead-flat plains exist (most of the plains having quite considerable gradients), and most of the larger streams or rivers are cut too deeply into the plains to permit of large quantities of water being easily diverted. Consequently it is not surprising that wild flooding was practically non-existent among the many small irrigation projects of the pioneer irrigators. The numerous small streams with which the foothills abound attracted their attention, with the result that almost all the older irrigated lands of Central Otago are on hillsides, and are irrigated by the contour-ditch method. There are, however, one or two instances of wild flooding, the most noticeable being on Mr. J. Lethbridge's property at Ardgour.

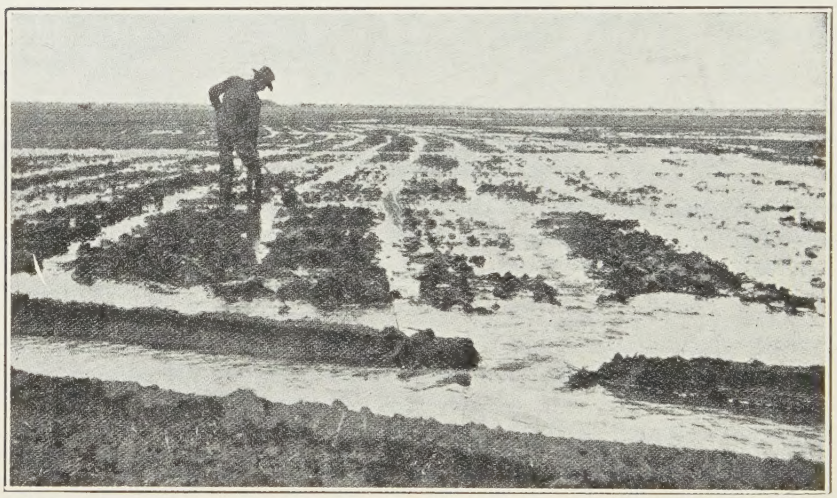

FIG. 21. WILD FLOODING.

In more recent years Government irrigation schemes have provided for the supply of water upon a much larger scale, and largely to the intermediate plains of moderate slope. Many of the settlers are, unfortunately, endeavouring to irrigate by one or other of these primitive methods lands which are neither flat and even enough for wild flooding nor steep enough for contour ditches. They are using more water than is economical or good for the land, and involving themselves in an extreme amount of unnecessary labour. In making this statement it is not intended to belittle the intelligence of these settlers, who are mostly inexperienced in irrigation, and until recently had only the examples of the older irrigation to be guided by. Some of them have, in fact, brought considerable intelligence to bear upon the situation, and have unconsciously adopted methods closely approaching some of the more modern systems; but too frequently they have not adopted the most efficient method for their particular areas. They should

realize that in attempting to evolve methods of their own they are wasting time, trouble, and expense. They are going over old problems which have been solved in older countries by previous generations of men whose knowledge, gained by trials, failures, and successes, is available to any one who will spare a few hours to read and study the many excellent works on irrigation now obtainable. Instead of delving in the dark, new irrigation settlers should carry on from the point reached by others and devote their energies to further improvements in methods.

It is admitted that the new settler placed upon a bare plot of land, without fencing or building, has his side of the question. He has to put labour and money into his section for some time before he can get a return. Meantime he has to live, and it is quite understandable that his first inclination is to irrigate his land, in order to produce something, by any method, or lack of method, so long as it will make something grow quickly and without much initial cost in preparing the land. In some circumstances he may be justified in starting by roughly irrigating most of his farm by any crude method, with the final object of going back over it later to redevelop upon more efficient lines. However, he should avoid laying down fields in permanent crops on any but the most efficient lines.

METHODS OF SURFACE IRRIGATION.

There is some diversity in the nomenclature of some of the recognized methods, but the writers propose to enumerate the principal ones, and later describe and comment upon them under certain designations, which will be adhered to throughout these articles.

For general field irrigation the following list enumerates six of the principal methods, arranged in their order, with relation to the steepness or gradient of the lands upon which they are, in the opinion of the writers, generally most suited for adoption (commencing with the steepest lands): (1) Flooding from contour ditches; (2) flooding from field laterals; (3) the border-ditch system; (4) the border-dyke system; (5) the basin-check method; (6) wild flooding.

The first and last of the foregoing are the primitive methods which, as already explained, appear to have first suggested themselves to man, while the intermediate ones are the outcome of centuries of practice. While no one of them is entirely condemned under its most favourable conditions, it is intended to suggest the circumstances under which each might most economically and efficiently be employed. In these suggestions it will be found that the degree of gradient of the land is generally taken as the principal factor in deciding which method should be adopted. There is no doubt that the texture of the soil, its power to resist erosion, and its degree of porosity must have some bearing upon the matter. Also, the volume of flow of water which the irrigator may have at his command should influence the selection of a method or a modification of the same, as would also the class of crop to be grown. But these are minor considerations as compared with the general one of gradient, and the writers therefore believe that the intelligent irrigator will, from the remarks about to be made, be able to modify the general recommendations to conform with the particular characteristics of his own fields. It should be added that the writers

have in view mainly the irrigation of pastures and permanent fodder and hay crops, and to some extent cereal crops.

Time and further experience may eventually cause the writers to modify or alter their views in some degree, but it is here perhaps appropriate to state that the recommendations about to be made are based upon their personal observations, much study of the subject, and a very intimate knowledge of conditions in Central Otago, for which district their recommendations are essentially designed.

For orchard-work, market-gardening, and certain field crops a further method known as "furrow irrigation" is frequently used; and for several classes of production one or two other methods, involving the reticulation of the water through pipes, will be referred to under the general heading of "pipe irrigation." These will be dealt with in a later article.

Flooding from Contour Ditches.

The general principles of this method have already been referred to. Fig. 22 shows a field laid out for irrigation on these lines. The distributory ditches or furrows follow very nearly the contours of the land. It is the only method which can be recommended for very steep land, and is quite efficient for any slopes of 3 ft. per chain or steeper. Slopes as steep as 30° are frequently in evidence in Central Otago growing clover and grasses well under this method. It can be used for flatter slopes than 3 ft. per chain, but becomes uneconomical, in duty of water and labour costs, as against other methods. It has the inconvenience of many furrows or contour ditches placed irregularly about the land, but, as the steep lands upon which it is recommended are usually only capable of being used for grazing purposes, this does not matter much. These steep lands usually grow very sweet grasses, and, no matter how steep or rough-looking, every part of them should be utilized by the irrigation farmer.

The chief point for caution is to make the contour ditches small, so that it is impossible for a large flow of water to concentrate and cause damage. One good plough-furrow should usually suffice, and the flow of water used should be between $\frac{1}{8}$ cusec for very steep land and $\frac{1}{2}$ cusec on the easier slopes. The gradient of the contour ditches should be kept fairly low (say, about 6 in. of fall per chain), so that the water may easily be made to overflow from them in many places at once. The distance between contour ditches should be in the vicinity of 2 chains, and the distance which water is run along any contour ditch should not exceed about 5 chains; that is to say, the supply-ditches should be about 10 chains apart and contour ditches run each way from them. Using contour ditches of too great length will involve unnecessary loss of water on the way. The supply-ditches, which are directed straight down the steep hill, must be stone-pitched or constructed of wooden or iron fluming to prevent erosion. However, being very steep, these supply-ditches need only be of small dimensions. Sheets of ordinary corrugated galvanized iron placed end for end with a short overlap, and bent sideways into semicircles, form good protection in supply-ditches. Sometimes a natural flat-bottomed gully is used as a supply-ditch, the water being

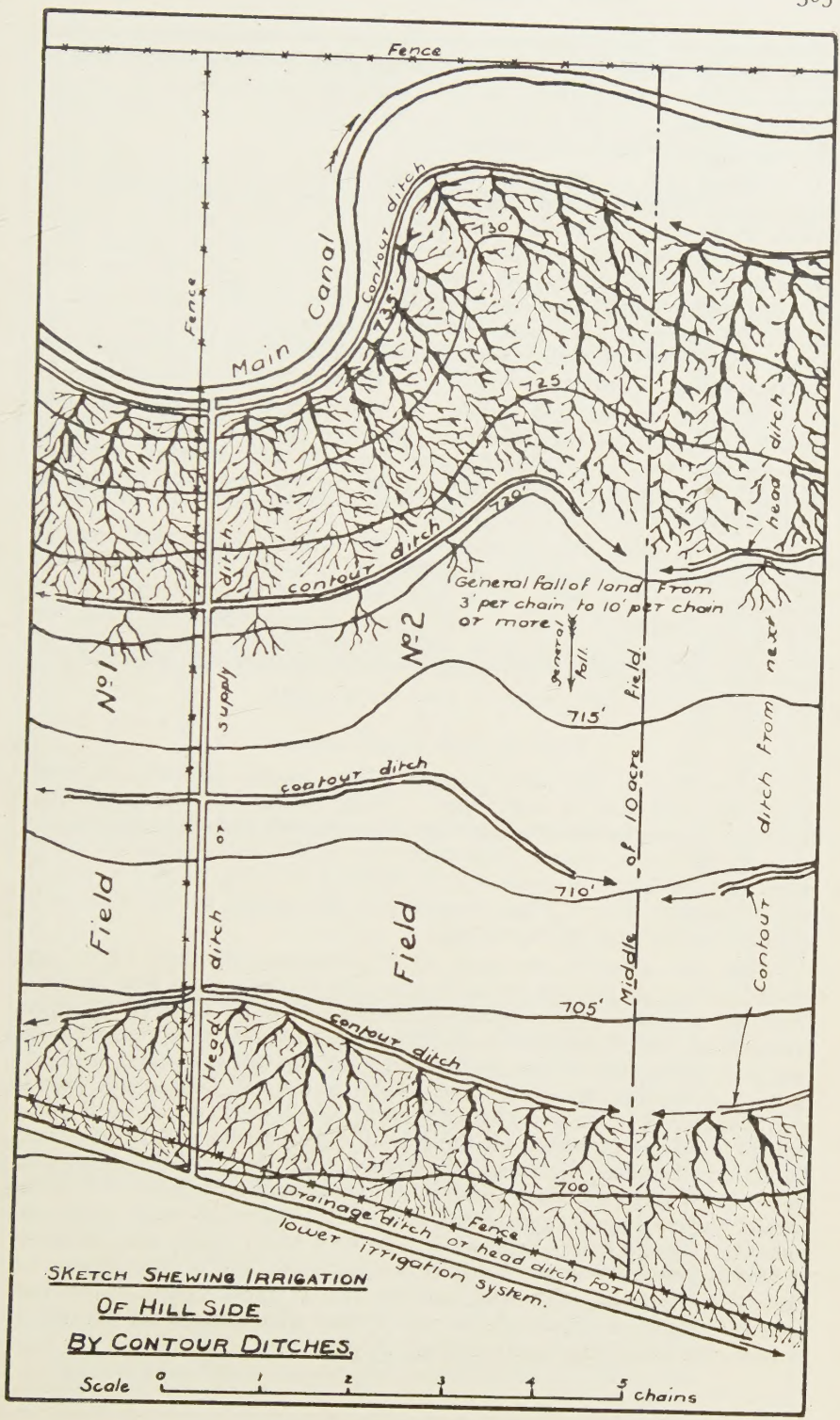

FIG. 22. [Original.

allowed to run down unrestricted. This is not recommended, as the gully either erodes or becomes choked with swamp-grasses, which retard the water too much, thus permitting the gully-bottom to absorb too much water, which is likely to come out lower down and cause damage to lower lands by overwetting.

The operation of irrigating is usually worked downward from the top contour ditches, which are shut off as soon as their portions of land are watered. Meantime, any water which escapes from the upper levels will be collected by the lower ditches, and will go towards the fulfilment of their duties. In the initial laying-out of the field the supply-ditches should first be constructed, and the top contour ditch should be made and set in operation. Then the irrigator may decide the exact position of each succeeding contour ditch, as he observes the distance which the water from the one above reasonably irrigates.

The initial cost of this method of irrigation is about £2 10s. per acre for iron for the supply-ditches, plus the small labour of making contour furrows. The latter may be done by the irrigator, but for purposes of comparison it is estimated at 10s. 6d. per acre, making a total initial cost per acre of £3 0s. 6d.

As only a small flow of water can be utilized under this method with safety it is rather slow in operating, and may take sixty hours to irrigate a 10-acre field. This may have to be repeated eight times during the irrigation season. After grass is established to hold the soil the irrigator need not be in constant attendance, but will have to leave his other duties several times a day to redirect the flow; or the work, being very light, may be done by a youth.

Flooding from Field Laterals.

As the slope of the land becomes easier, though still of a decided degree, the thin film of water from contour ditches travels too slowly, resulting in over-irrigation near the ditches and complete disappearance of the water before irrigating reasonably wide strips of land. Some method becomes necessary of assisting the flow of water downwards, concentrating it upon a small area for a brief period, and then quickly transferring it to another.

While the slope of the land is still between 3 ft. and 1½ ft. per chain this can be effected by the method of flooding from field laterals (Figs. 23 and 24). The head ditch, instead of being directed straight downhill, is taken somewhat diagonally across the slope, preferably (but not necessarily) at the greatest gradient the soil will stand without protection against scouring. Most soils in Central Otago will stand a grade of 1 ft. 6 in. per chain in fairly small ditches not used constantly and thus protected on the sides by the natural growth of grass. Lateral ditches, on the steepest gradient permissible with safety, are then run off from the head ditch, in an opposite diagonal direction with respect to the general slope of the land. This will make their direction somewhat square to the head ditch. From ½ to 1½ cusecs may be used in this system, the water being concentrated to one or two points in one of the laterals at a time, and let out at these points on to the land by means of canvas dams, which may also be used for diverting it from the head ditch into any lateral (Fig. 25).

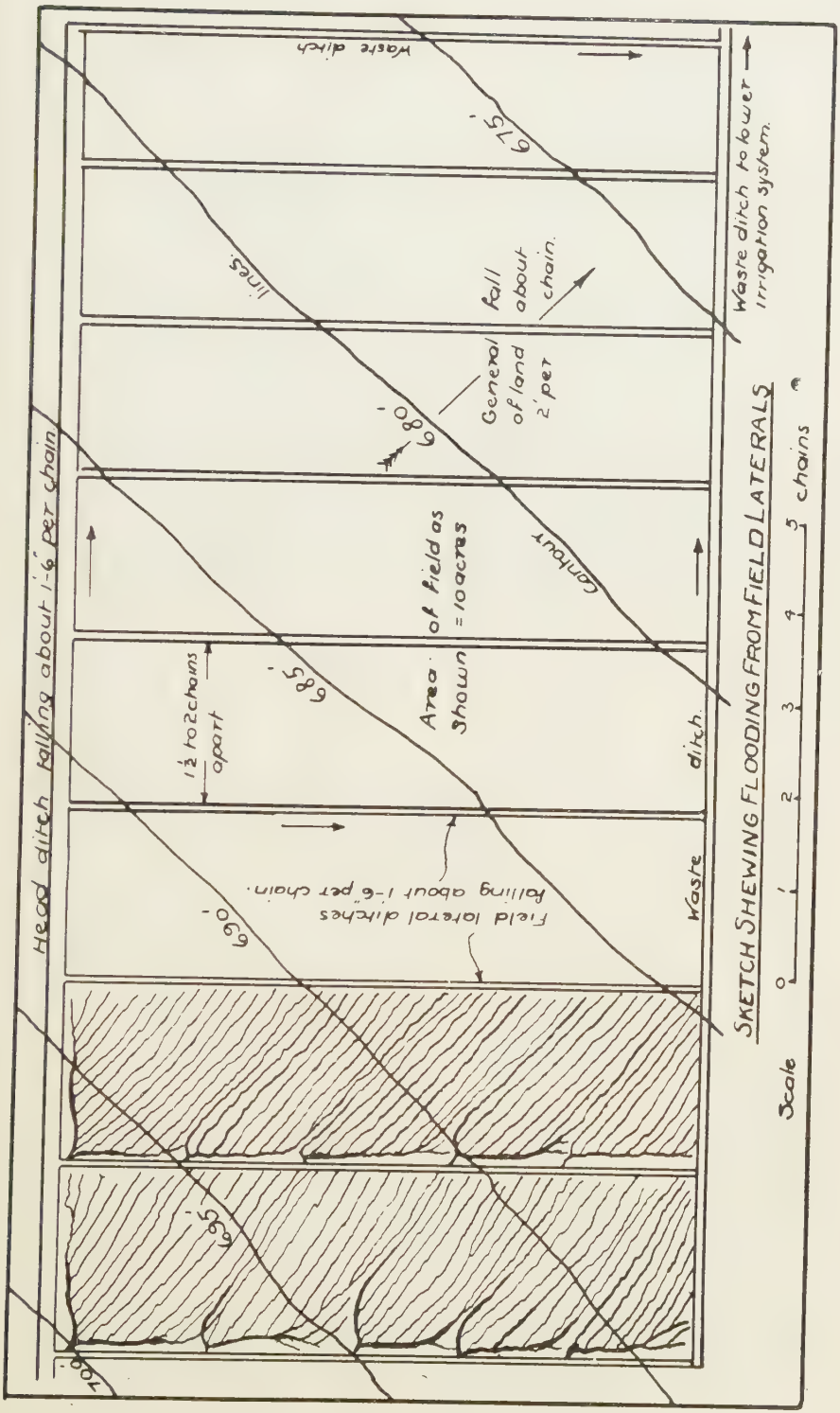

FIG. 23. [Original.

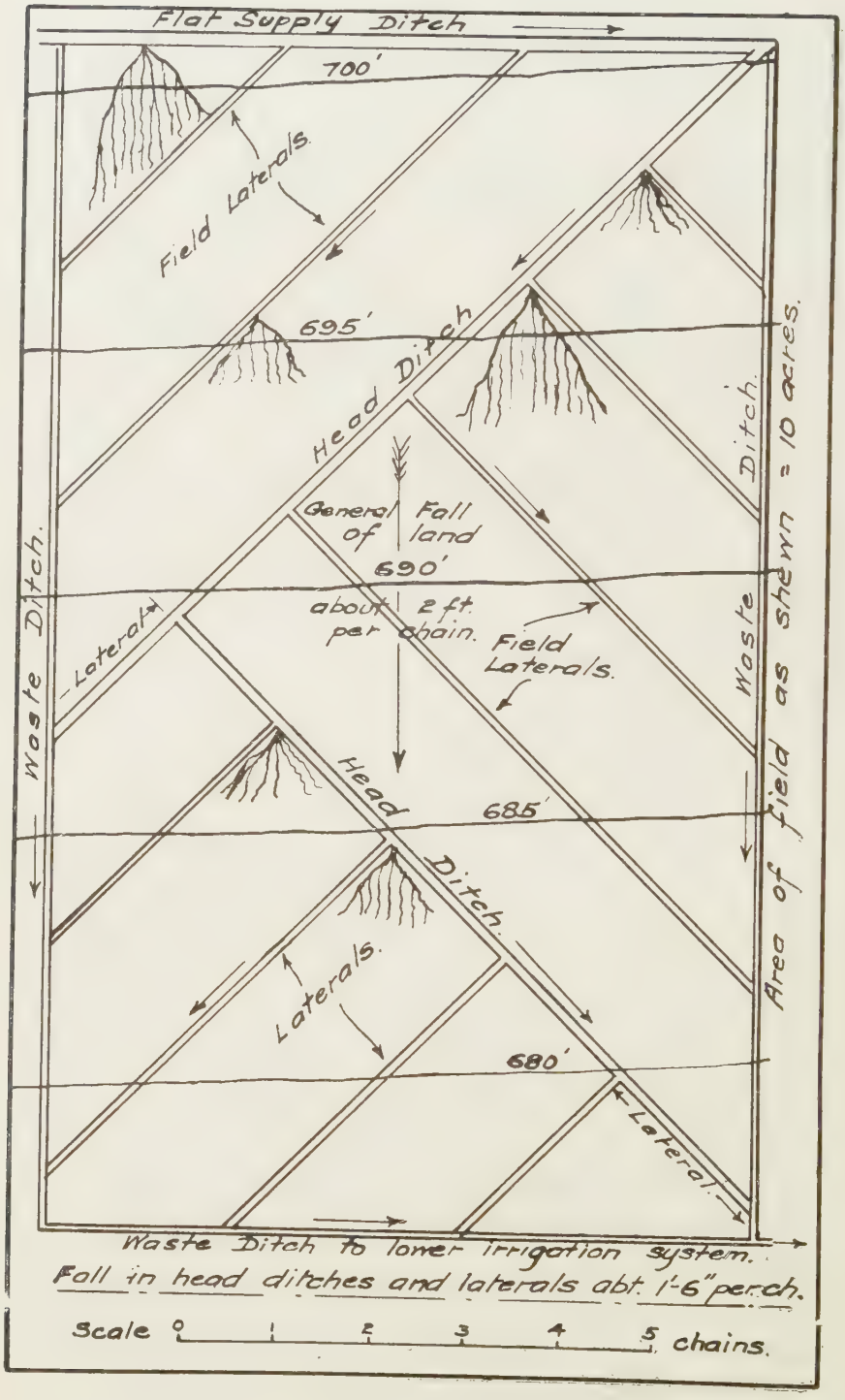

FIG. 24. SKETCH SHOWING FLOODING FROM FIELD LATERALS.

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FIG. 25. DIVERTING WATER ON TO LAND FROM FIELD LATERAL, USING CANVAS DAM.

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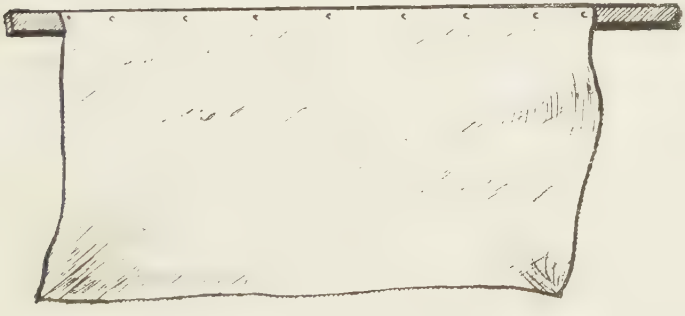

FIG. 26. CANVAS DAM.

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The canvas dam (Fig. 26) is used by resting the rod across the top of the ditch, preferably before the water reaches it, hauling the slack end up-stream, letting it sag into the shape of the ditch, and anchoring it down with sods. It will thus form a fairly watertight dam capable of being moved easily. It is preferable to have a few of these canvases, so that they may be set in advance.

In Fig. 23 the field is assumed to have its main fall running diagonally across it, and in such a case the ditches will run about parallel to the sides of the field. If the fall were directly down the field the system of ditches would be arranged as in Fig. 24.

The whole of the preparation work for this system can be done by the irrigator at a cost estimated at £1 5s. per acre, which is the total cost of preparation. When operating, a man must be in constant attendance. He should, however, be able to irrigate 10 acres in thirty-six hours. The method is a good one, but should be confined to land with about 2 ft. of fall per chain.

Border-ditch Method.

As soon as the slope of the field becomes easy enough to permit water to be run directly down it in ditches without damage the two methods previously described should be abandoned and the border-ditch method used (or one of the methods described later).

Fig. 27 shows the use of this method. The head ditch is taken across the top side of the field on a fairly flat grade, so that if dammed in one place it will back up the water to discharge into two or more of the branch ditches at one time. The head ditch will have to be fairly large, on account of its low gradient, in order to carry a flow of water of, say, 3 or 4 cusecs. The branch ditches are taken off from the head ditch, at intervals of about 70 ft., straight down the fall of the field. They need not be so large, as they will have a considerable gradient. Two furrows thrown in opposite directions and trimmed up a little will form one of these branches. The canvas dam is used for diverting water into the branch ditches (Fig. 28), and also for diverting it out of the latter on to the land (Fig. 29) in a very similar manner to that employed in the field-lateral method. One difference from and decided advantage over the latter is that the border-ditch method waters on both sides of the ditch, and the raised edges of each ditch form borders, confining the flow of the water directly down definite strips of land. Hence the name "border."

The film of water on the land being thus confined very materially reduces the amount of attendance required. One man should be able to irrigate a 10-acre field in fifteen hours.

In the previously described methods, recommended for steeper lands, slight inequalities of the land-surface do not matter much, but in this system it is desirable that the surface be made fairly regular by a little grading, if necessary (though a very high degree of evenness is not absolutely essential). Allowing for a moderate amount of surface-levelling and the construction of the ditches, all of which may be done by the settler himself, the cost of preparation is estimated at £2 12s. 6d. per acre. This method can be used on land with a slope of 1½ ft. per chain or considerably less. It is fairly efficient, and probably the best method to use on lands with slopes between 1 ft. and 1½ ft. per chain. However, on lands having less than 1 ft. of fall per chain there should be no hesitation in discarding it for the border-dyke method.

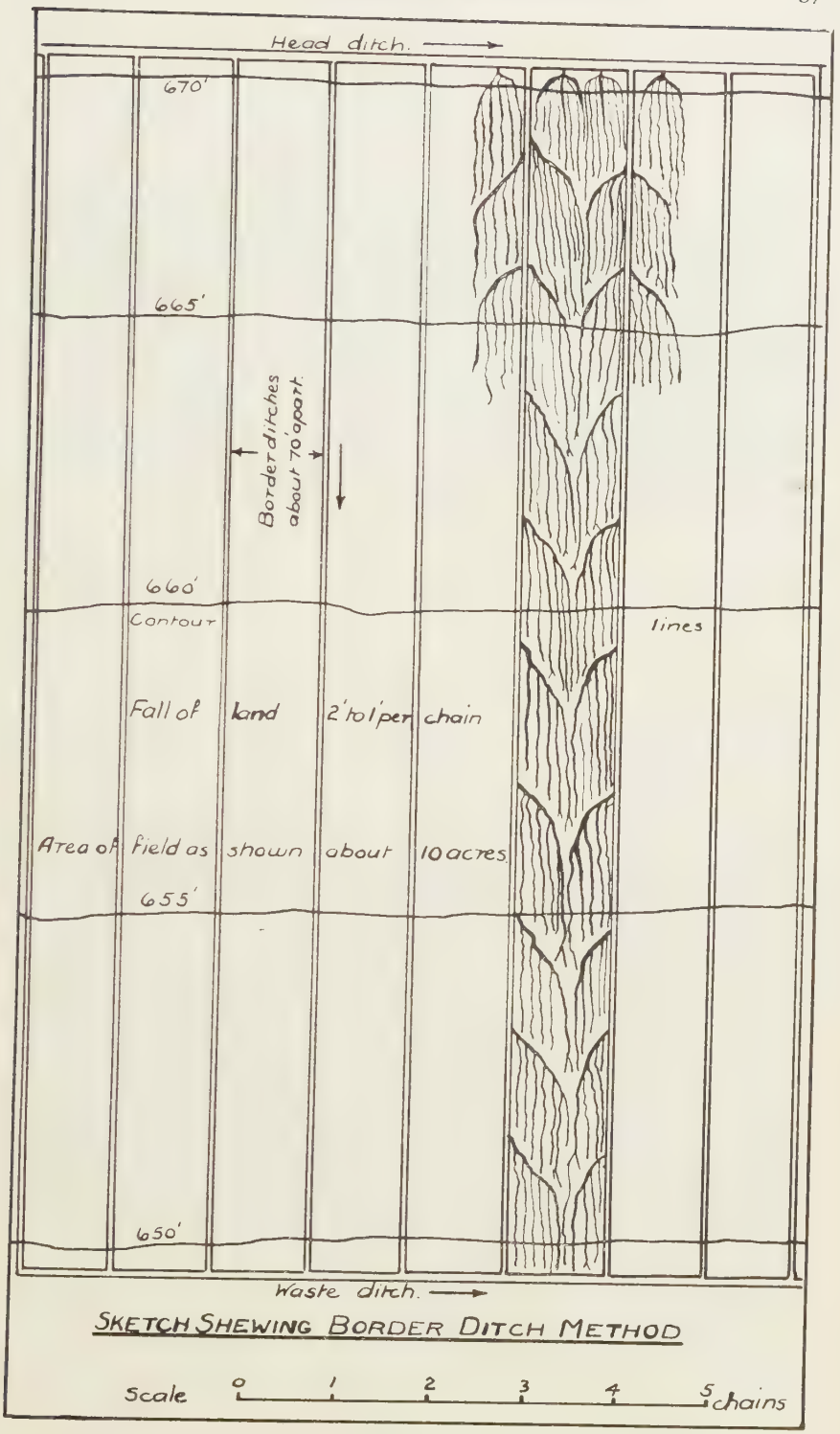

FIG. 27.

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FIG. 28. DIVERTING WATER FROM HEAD DITCH INTO BORDER DITCH WITH CANVAS DAM.

[*Canadian Bulletin No. 6.*

FIG. 29. CANVAS DAM IN POSITION TO IRRIGATE FROM BORDER DITCH.

[*King—"Irrigation."*

Border-dyke Method.

For flat land this method (Fig. 30) is undoubtedly the most efficient, and, though expensive in first cost, is in the long-run the most economical from every point of view.

The head ditches should be formed almost on a dead flat, across the upper end of a field and at further intervals of 10 chains, and, being flat in gradient, must be fairly large, as the method involves the rapid use of a comparatively large flow of water. Instead of leading the water down the field and distributing it in smaller ditches, as with the border-ditch method, it is put on to the land direct from the head ditches. The border ditches are replaced by small levees, ridges, or "borders" running down the direct slope of the land and dividing it into strips. If the land is level across the field, as in the lower half of Fig. 30, the strips will be regular and parallel to the sides of the field. On the other hand, if there is slight irregularity in the contour the strips may be curved to run always at right angles to the contour. In other words, the direction of the borders will follow the steepest direction of fall at each point in their progress from the head ditch. This is to ensure that each strip will be perfectly level in cross-sections at every point. For operating, a large flow is let into the top end of a land. It spreads into an even film a few inches deep confined between the borders, and travels right down the full length of the strip (Fig. 31), watering the land in that strip evenly and thoroughly.

Experiments and experience have shown that the strips should not be more than 10 chains long (the writers are inclined to recommend about 7 chains) and 50 ft. wide. The levees or borders should be about 7 in. high at the start, where the film of water will be deepest, reducing to a couple of inches at the bottom end, where the water should have been reduced in depth to practically nothing by absorption *en route*. These borders are formed by ploughs assisted by a special ridger (Fig. 32). They should be a few feet wide at the base, so that when they have settled and rounded off they resemble gentle waves rather than sharp ridges. If so formed they will present no obstacle to a reaper or other farm implement.

The volume of flow of water used will be decided by the slope of the land, other things (such as the porosity or rate of absorption of the land) being equal. On average porous Central Otago land, for giving a watering equal to about 3 in. of rainfall the film of water should only be on the surface of the land at each point for about thirty minutes. Enough water to irrigate a whole strip must therefore be allowed to run into the head of it in thirty minutes. By this time the travelling end of the film of water will (if the volume of flow has been large enough) have reached roughly four-fifths of the way towards the end. The supply is then cut off at the head ditch and transferred to another strip (or "check," as they are commonly called). The film in the first check will continue to move forward by the accumulated water in the upper end passing on, and if everything has been gauged rightly should just peter out at the bottom end.

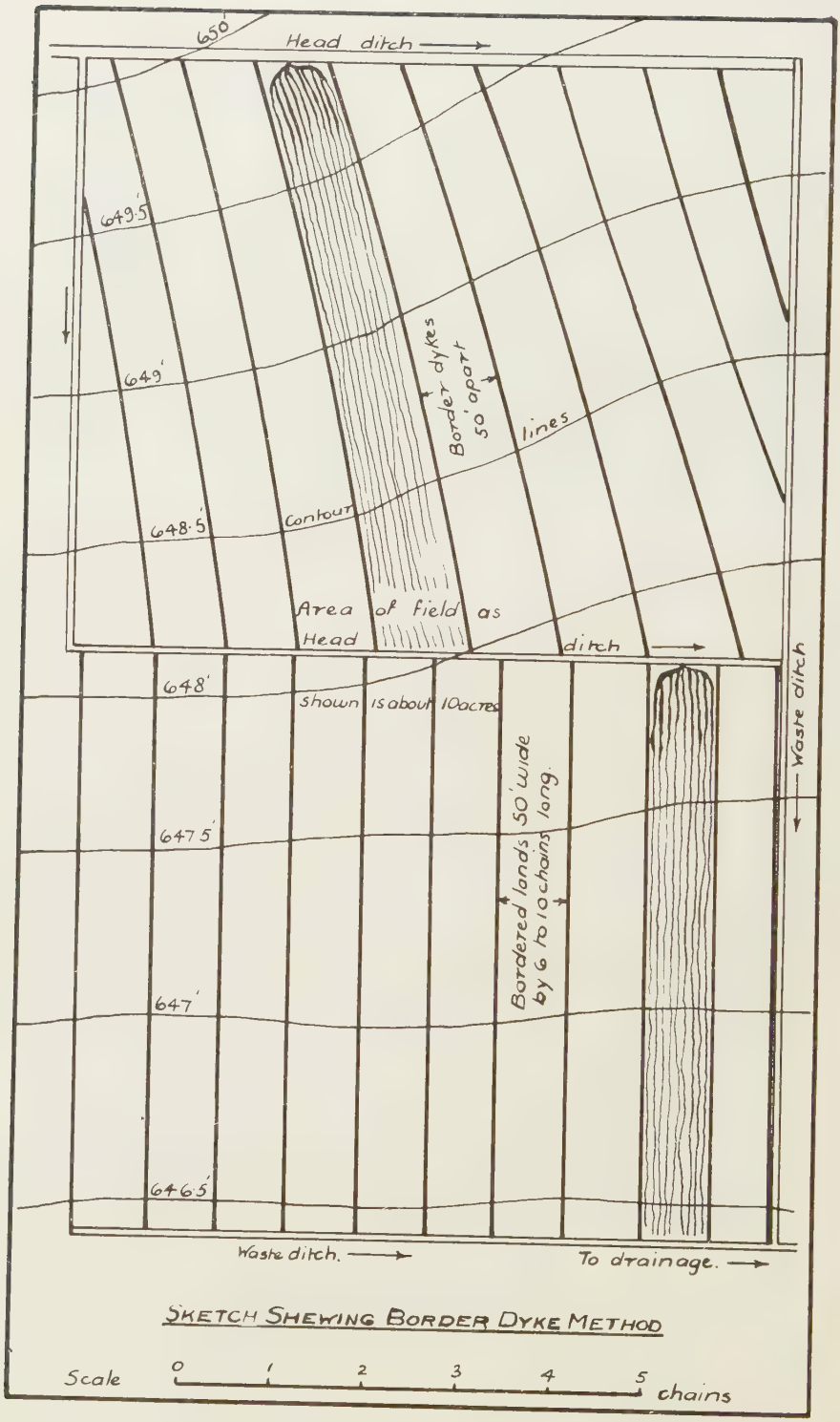


FIG. 30. [Original.

FIG. 31. FILM OF WATER FLOWING DOWN BETWEEN BORDERS IN BORDER-DYKE METHOD, AT GALLOWAY EXPERIMENTAL AREA.

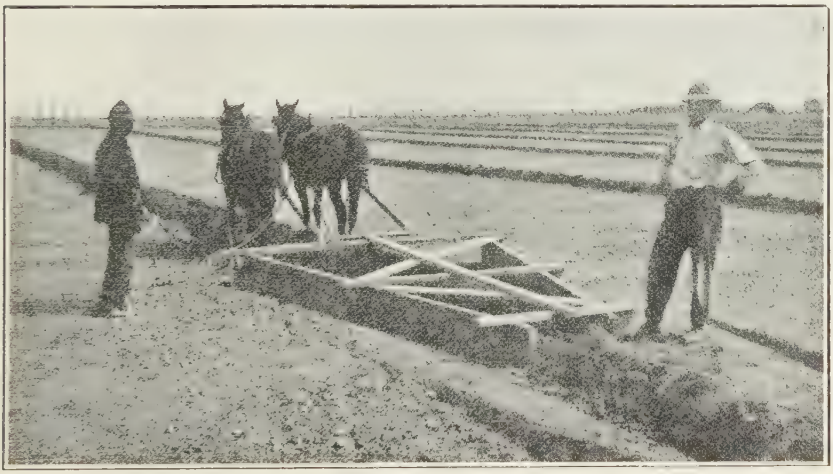


FIG. 32. USE OF RIDGER FOR FORMING BORDERS.
[*Canadian Bulletin No. 6.*

It might appear at first sight that this method would over-irrigate the top end and leave the lower end underwatered. However, this is not so. The amount of water which soaks in at any point is not dependent upon the depth which may be passing over the surface at that point, but rather upon the length of time during which free water of any depth has been resting on the surface. Almost immediately the supply is cut off, the film at the upper end, being a few inches deep and thus having more velocity, runs forward, leaving the surface there uncovered. But its progress at points lower down is slower and slower. It therefore takes longer to run off these lower points, and this happens to compensate in a remarkably correct

manner for its not having reached these lower points so soon when the supply was coming on.

The volume of water used should be adjusted by trial to give the proper effect. Roughly, for land with a gradient of 1 ft. per chain a flow of about 3 cusecs should be used, increasing to 6 cusecs when the gradient reduces to 3 in. per chain. Not often will land be found to have a lesser fall than 3 in. per chain, but this method can be used for very much flatter land by increasing the size of flow. As the whole essence of this system is speed and precision, canvas or sod dams are not recommended; but a simple wooden gate should be set in the side of the head ditch leading to each check. Also, one of these gates will be necessary in the branch ditch leading from one head ditch to the next, so as to hold back the water in the upper head ditch while it is in use. These gates should be about 6 ft. wide but only one board deep: that is to say, the movable part consists of one board, with handle to lift it by, set in a simple frame (Fig. 33).

It will readily be seen that the land must be smoothed perfectly and made quite level in cross-section, or the film of water would run all to the low side. The main levelling, such as cutting off decided hummocks and filling into hollows, is done in the first place with horse scoops or scrapers, and the finer levelling by special implements (which can be home-made). Even the slight hollows made by the removal of the soil for the borders must be refilled by scraping a little soil into them from the middle portion of the lands, and the ordinary road-grading machine comes in very useful for this work. The matter of irrigation implements will, however, be dealt with more fully in a later article.

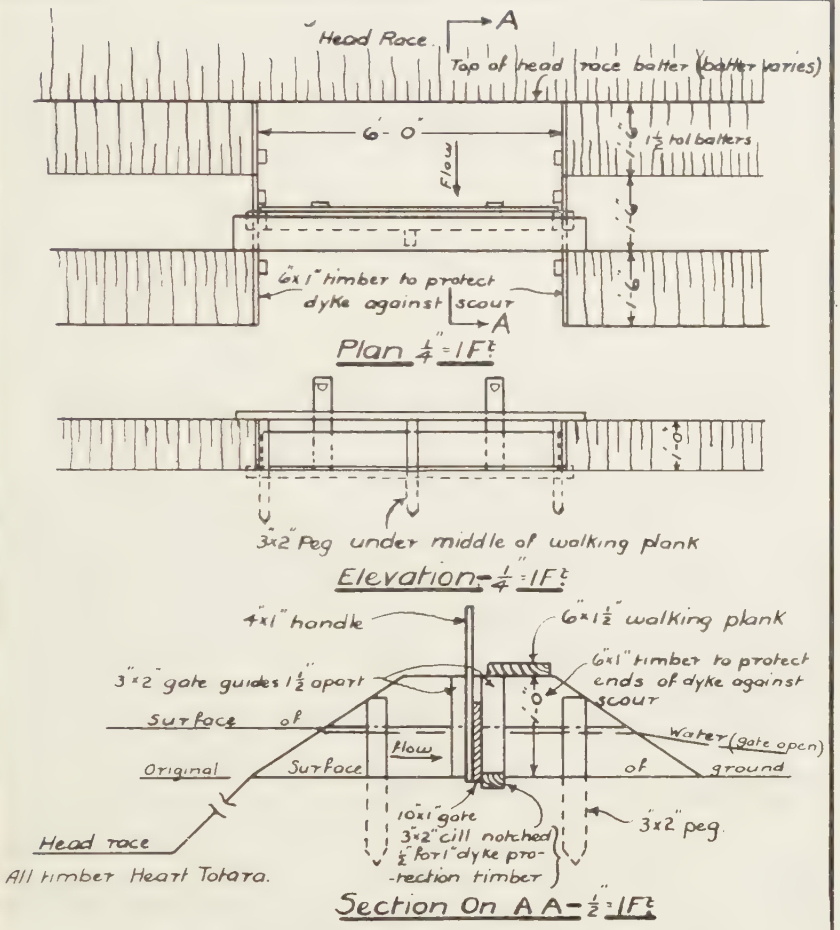
The initial cost of preparation for the border-dyke method is much higher than for any of the others yet described, being as follows per acre:—

	£	s.	d.
Labour making head ditches	2	0	0
Making borders	0	18	0
Levelling field (varies)	1	0	0
Making head-gates	0	7	6
Total labour (including horse-hire)	4	5	6
Materials for head-gates	0	14	6
Total initial cost per acre	£5	0	0

It will be seen that only a very small portion is for material, and that all the rest can be done by the farmer and his teams.

Though the initial cost is much higher than for other methods, it should be remembered that it is non-recurring, and it is amply justified by economy in labour for all time thereafter, in the amount of water used (which has to be paid for), and, still more important, in evenness of irrigation, ensuring the best crops. The work when done is an added and visible improvement to the capital value of the land.

By this method one man can irrigate 10 acres in eight hours, and, what is more, knows that every inch of it has been done thoroughly. It is the only really scientific method known, and settlers should be prepared to undertake very considerable grading and levelling work to adapt even very uneven land to its use.



Material List For One Gate.		
Section	Numbers & Lengths.	Where Used.
3"x2"	3/1'-9" 1/6'-9" 4/1'-0"	Pegs, Sill & Gate Guides
10"x1"	1/6'	Gate
4"x1"	2/1'-9"	Gate handles
6"x1"	1/12'	Against ends of Dyke. To be cut.
6"x1½"	1/7'	Walking plank.
nails		

SKETCH SHOWING TYPICAL OUTLET GATE FROM HEAD RACE INTO CHECK

FIG. 33. [Original.

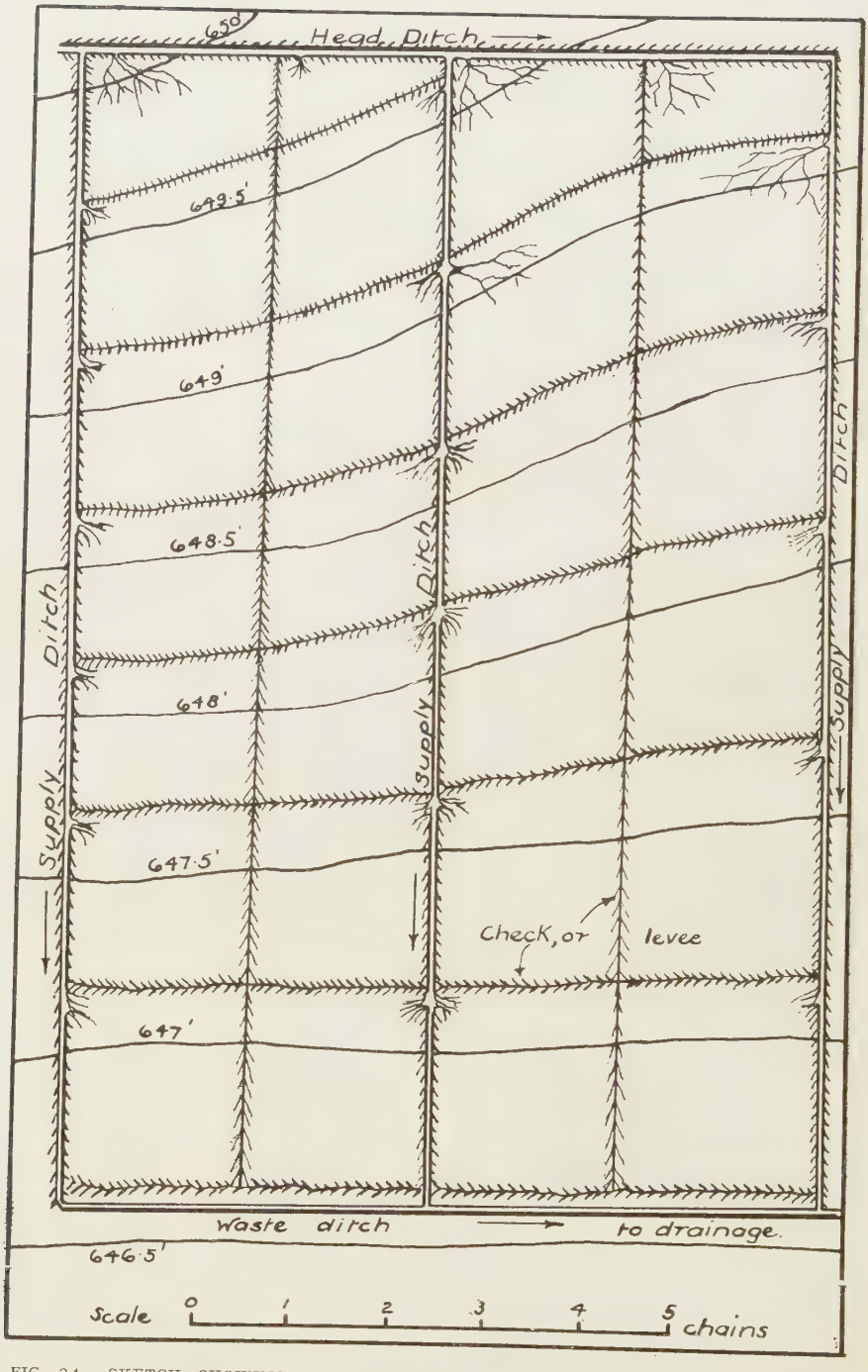


FIG. 34. SKETCH SHOWING SAME FIELD AS IN FIG. 30 UNDER BASIN-CHECK METHOD.

[*Original.*

Basin-check Method.

This is a method (Fig. 34) which, though very old and adapted for very flat land, has been largely replaced for field irrigation by the more speedy and labour-saving border-dyke method. It consists essentially in forming basins or ponds on the land by throwing up slight mounds or checks and flooding each consecutively. For market-gardening and orchard irrigation (Fig. 35) it is still recommended in the right circumstances. Where the land is practically dead-flat and even, the basins will be rectangular and regular, but if on a slight slope they will conform in shape to the contours of the land.

FIG. 35. BASIN-CHECK METHOD USED IN ORCHARD.

[Mosier and Gustafson—"Soil Physics and Management."

The size of each pond will depend upon the flow of water available. The method would not be practicable to use on fields with a slope greater than about 6 in. in 2 chains (unless the irrigator were prepared to terrace the land). In Fig. 34 the field has about the maximum slope as mentioned. The hatched markings represent slight levees which could be formed with a plough. Those running across the field would be 6 in. high throughout, to pond up the water that height and make it back up to the upper edge of each enclosure. The ridges running up and down the field would have practically no height at the upper edge of each pond and increase to 6 in. at the lower edge.

For a lay-out as shown in Fig. 34 a flow of about 5 cusecs would have to be applied to each basin for about fifteen minutes. It would then be turned into the next lower basin, and the embankment between the two immediately cut to allow the surplus water impounded in the upper basin to also run into the next. It would cost fully £6 per acre to prepare properly with gates, and, though just about as speedy as the border-dyke method, would take two men to operate over the same area. This means that it would be about twice as costly to manipulate. It is recommended only for odd corners of a field not large enough to set out in borders.

Wild Flooding.

This method cannot be recommended under any Government irrigation scheme. In very exceptional circumstances, where plenty of water is available without extra cost and good drainage exists, it might be employed.

Summary of Costs and Expenses of Surface-irrigation Methods.

The following is a summary of the per-acre costs and operating-expenses of each system described, assuming eight irrigations in a season :—

Table 9.

Method.	Initial Cost.			Annual Cost of Operating.
	Labour.	Material.	Total.	
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Flooding from contour ditches (man two-thirds time)	0 10 6	2 10 0	3 0 6	2 10 0
Flooding from field laterals ..	1 5 0	..	1 5 0	2 8 0
Border ditch	2 12 6	..	2 12 6	1 0 0
Border dyke	4 5 6	0 14 6	5 0 0	0 10 8
Basin check	3 16 6	2 3 6	6 0 0	1 1 4
Wild flooding	..	..	..	..

NOTES.—Labour is allowed for at 13s. 4d. per eight-hour day. Horse-hire is included with labour at 7s. per eight-hour day for each horse. Ordinary cultivation has not been included in cost of preparation of the land. The cost of the wild-flooding method is extremely small, but not possible to estimate.

The Influence on Agriculture on International Relations was a subject considered by the Paris International Congress of Agriculture last year. It was held that an association of the leading agricultural and pastoral societies of the world would lead to the development of sound international good-fellowship, and the elaboration of a common programme for the benefit of world agriculture.

Noxious Weeds.—The Tomahawk Road Board has declared Californian thistle not to be a noxious weed within its district. The Foxton Borough Council has declared the whole of the plants enumerated in the Third Schedule of the Act to be noxious weeds within that borough. Matakaoa County has declared Bathurst burr, foxglove, gorse, milk thistle, and Japanese wineberry to be noxious weeds.

THE BUSH-SICKNESS INVESTIGATION.

LABORATORY WORK AND RESULTS.

(Continued.)

B. C. ASTON, F.I.C., F.N.Z.Inst., Chemist to the Department.

SOME DISCARDED HYPOTHESES—*continued.*

In the early stages of this investigation the livers of the affected animals were specially examined for inorganic (mineral) poisons, which are usually retained in greater amounts by the liver than by any other organs or tissues. Copper was found to be present in greater amounts than was suspected to be normal, judged by European experience, which raised the presumption that copper might be acting as a slow cumulative poison. This possibility was thoroughly investigated. Many specimens of livers and other organs from bush-sick and healthy animals were obtained from both cattle and sheep, and the copper was accurately determined by gravimetric and colorimetric analysis. Feeding experiments were carried out with sheep, calves, and rabbits over a period of seventeen months, and, although the livers of the animals fed with copper-salts were found to contain abnormal amounts of copper, larger than anything met with in the examination of the bush-sick animals, no evidence could be obtained to show that the copper ingested had exercised any injurious effects. The results were published fully in *Transactions of the New Zealand Institute*, Vol. 44, 1911, p. 288. Investigation showed that the high copper content of the livers of bush-sick animals was an abnormality shared with healthy sheep killed for consumption in parts of New Zealand other than the bush-sick area. Analyses of grass-ash and soils did not show any exceptional amounts of copper.

Poisonous elements generally have been sought for, and spectroscopic examinations made of the ash from animals and plants, and of soils from the affected area, with a view to detecting unusual quantities of the rarer elements which might have a poisonous effect on the animal. Entirely negative results were obtained in these analyses.

POSSIBLE AND PROBABLE HYPOTHESES.

There is therefore, in the poison hypothesis, only the possibility of a poisonous organic compound developing in or on the pasture to consider. This is such an unlikely suggestion that it has not once been made by any of the distinguished authorities whom the writer has consulted upon the matter, nor by local veterinarians, many of them particularly able men—such as the late J. G. Clayton—who have from time to time engaged in the field-work. In fact, the slow-poison hypothesis has been suggested only with the view that some mineral or inorganic poison, such as arsenic, might be present. The idea that some cumulative vegetable (organic) poison, alkaloid, glucoside, or other toxin might develop in or on the grasses and clovers grown on pumice lands has been advanced only in a general way by farmers, who assert that the clover is bitter to the taste, and that stock manifest

an indifference to it—a fact which may be explained on other grounds (see later paragraph dealing with balance of food constituents). It seems extremely unlikely that the same organic poison should be produced in such differently related plants as clovers and grasses, and yet animals seem to develop bush sickness impartially, either when the pasture is almost wholly clover or when it is mostly grass.* Again, if a slow cumulative poison is at work the addition of a comparatively small amount of food grown outside the affected area, such as bran, molasses, &c., or turnips and hay grown on the premises, should not, one would think, render the animal immune to the poison, or, what is still more improbable, effect a cure when the animal is once sick—bearing in mind that the animal is still feeding on the food, although in diminished amounts, which is suspected of contributing the poison.

The underlying idea in most minds which have considered the problem has been expressed in the form of a deficiency hypothesis, or, in other words, a starvation due to "something wanting in the soil," as the man on the land phrases it. The writer has, however, an open mind on the possibility of an organic poison being a contributing cause of bush sickness, considering the clovers belong to the Leguminosae, a family which contains certain plants known to produce chronic poisoning in men and animals under the names lathyrism and locoism, the active principles causing which have so far evaded all attempt to isolate them.

The other matter to consider is whether the organic nutrients are properly balanced in the food-supply, and in this respect there is decidedly room for research. The writer has seen farms on which there was little else to be perceived but clover, and in this case one would think that beasts pastured thereon were getting too much protein, there being possibly not enough grass available to sufficiently dilute the natural pasture. In one case the writer noticed that wherever the cattle could get a patch of grass they had grazed it closely down, leaving a bare patch surrounded by tall clover. The cattle on one farm in the clean area were certainly not looking as well as they should, and there was here everywhere a rank growth of clovers and little grass to be seen. It is therefore quite conceivable that excess of proteids in certain pastures may result in an inferior condition in the stock through the difficulty of eliminating the excess of proteid phosphorus and sulphur, leading to the condition known as acidosis. Whether the sulphur when eliminated as sulphuretted hydrogen from the food ingested has any inhibitory effect on the assimilation of iron from the food is a subject for future research. It may, however, be observed that cattle beasts fed on pasture top-dressed with iron-salts, and which was proved by analysis to contain much more iron than the normal pasture on bush-sick land, passed dung which was much blacker in colour than usual, presumably due to the formation of sulphide of iron —a black compound.

On the ordinary bush-sick farm, where the pasture is that resulting from a surface sowing after a burn, the animal should be able to choose the quantities of each class of the ration, whether of the proteid-

* Experiments will, it is hoped, be set on foot to determine this point definitely.

yielding clovers or of the carbohydrate-yielding grasses, to enable a balanced ration to be consumed. The good results obtained in feeding molasses may have been brought about by effecting a better balance in the albumenoid ratio in the food, molasses being wholly carbohydrates. For the information of those not acquainted with New Zealand practice who desire to compare bush sickness with nutrition diseases in their own countries it may be pointed out that the growth of grass on the Patetere Plateau, where the Mamaku farm is situated (about 1,800 ft. above sea-level), is sufficient to provide the chief ration in winter. Milking-cows may be rugged, but store beasts are not, neither are they housed nor artificially fed. The only extra attention which they obtain during the three months of winter is that they may be given a little turnips and hay on those farms where any land has been brought under the plough. The growth of pasture is sufficient to keep stock in good store condition during the winter, especially if they have a little bush (forest) to go into for shelter during frosty nights or in cold sleety weather. This is assuming that they are not overdue for a change to healthy country—the farmer's method of combating the bush sickness, an expedient simple in itself but involving the use of change-paddocks or the possession of a second farm—a capital-absorbing proposition.

At this stage it may therefore be concluded the most feasible hypothesis is that there is some necessary constituent of the food-supply which is either not present in sufficient quantity in assimilable condition, or that some pathological condition of the animal induced by an abnormal or unbalanced food-ration (of organic or inorganic nutrients) is responsible for the condition known as "bush sickness" in ruminants.

It will be now necessary to discuss in considerable detail the actual conditions which prevail in the bush-sick country, in order that something may be evolved from the evidence which may be dignified by the name of "theory."

II. THE ROCKS AND SOILS.

According to Professor A. P. W. Thomas ("Report of the Eruption of Tarawera," Wellington, 1888, p. 19), the soils which will be taken as typical of the bush-sick country in this article, and on which the Mamaku farm stands, had their origin in what he calls the "Rotorua shower of ash." Other huge ash-showers have considerably modified the surface of the country in the thermal regions, and have also extended their influence to the east as far as the coast in Hawke's Bay and the Bay of Plenty. The Waikato River has carried pumice to the north and deposited it over a very wide area of country, influencing the subsoil as far north as Auckland City and weathering into clays, according to Jameson (*New Zealand Journal of Science and Technology*, Vol. ii, May, 1919). The Kaimanawa and the Ruahine Ranges have been well peppered with ash in the south, while in the west and south-west the volcanic rocks have left traces wherever water will flow and pumice will float.

For the present, in order that the results shall be as comparable as possible, it is intended to confine attention to the soils resulting

from the Rotorua ash-shower, except where others are inserted for the sake of comparison. This shower had its origin, Thomas considers, in a spot near Tikitapu and Rotokakahi, as the ash thickens in that direction, and has been spread out over a vast expanse of country. Thomas's description of the extent and nature of this soil-forming rock may be quoted in full; it is not capable of condensation, and the localities mentioned will aid in the comprehension of the incidence of bush sickness. He writes:—

All around the basin in which Lake Rotorua lies the present surface is formed by a pumice-ash some feet thick, in layers which follow the contour of the ground, the coarsest fragments being below, the finer at the top passing into brown pumiceous soil. The greatest thickness of the ashes, so far as I observed, was along the Wairoa Road, about three miles east of the Rotorua Township. There the ashes varied from 7 ft. to 10 ft. (in one place 15 ft.) in thickness. The surface layer, of course, consisted of soil, a brownish pumiceous loam stained with vegetable matter; this passed down into a brownish sandy substance, which doubtless represents the finer pumice ash, for small pumice-fragments were to be detected in it. This gradually becomes coarser and less decomposed in character till at 4 ft. from the surface it passes into unmistakable but fine pumice-ash. Below, the pumice-fragments grow larger, and are arranged in distinct strata with a peculiar wavy character about the layers, which reproduces the details of the stratification shown by the ashes of the late eruption of Tarawera. The coarsest fragments are at the bottom, and reach the diameter of 1 in. or 2 in., or exceptionally as much as 4 in. Below the pumice is a brown loamy layer, which doubtless represents the land-surface which was overwhelmed by the ashes above. About 85 to 90 per cent. of the fragments consist of a pumice weathered buff or cream-coloured outside, but white and fresh within. The remainder consists of fragments of obsidian, pitchstone, and various rhyolites. All the largest fragments are pumice.

The layers of this pumice-ash follow the present contour of the land, and this character, as well as the freshness of much of the pumice, seems to indicate that the shower took place at no very distant date—probably not long before the Maoris came to New Zealand. On the west side of Lake Rotorua are to be seen old lake-beds deposited when the water stood at a higher level, before the drainage-channel to the north was lowered. The lake had been lowered and the lake-beds subject to denudation before the pumice-shower fell, as may be clearly seen in the sections afforded by the road-cuttings.

I have traced the present deposit in various directions, and its characters conform everywhere to the principles formulated above. It will not be necessary to enter into details, but simply to state that to the west it may be traced for twenty-four miles along the Rotorua–Oxford (Tirau) Road. The soil in the forest along this road (Cambridge Bush) is brown; below it passes into a yellowish, more or less fine pumice-ash. The last distinct trace of this is seen at a point ten miles east of Oxford; but the character of the soil would seem to indicate that the shower extended farther to the west, though now all the fine ash is decomposed. To the north it may be traced along the Tauranga Road past Awahou as far as Oropi, thirty-two miles from Ohinemutu. Along the Maketu Road it may be followed as far as Waiwhakaretu (twenty-nine miles). To the south the ash may be seen at Pakaraka (eleven miles from Rotorua), where it is still several feet thick, and at Pareheru. It may also be traced still farther along the Wairoa Road to Tikitapu and Rotokakahi; but the thickness of the more recent ash renders continuous observation difficult here, and I have had no opportunity of detailed study.

It will be seen from this extract that the land-surface is here provided with a new covering of rock of such a physical nature that it speedily becomes a soil, unlike other rocks which require perhaps thousands of years to decompose and weather down into a state sufficient to support field crops. A very unusual feature is the attempt to predict the age of the deposit not in geographical time, but in terms

much less definite and remote.* Mr. Elsdon Best informs the present writer that Maori tradition—on which there is no greater authority than Mr. Best himself—places the arrival of the Maori in New Zealand at about forty generations back, which would mean something like one thousand years. The forest on the portion of the Patetere Plateau, near Mamaku, with which we are chiefly concerned, was probably all killed out by this great shower, and possibly the young forest which arose was something quite different and of a greater economic value than the forest it replaced, since pumice quickly becomes an excellent soil for tree-growth. The adjacent areas of rhyolite which have escaped the pumice-shower are now growing a very much older forest, the old trees of which consist of *Nothofagus fusca* (red "birch"), *N. Menziesii* (Southland "birch"), and *Metrosideros robusta* (northern rata) of a very much greater age than anything on the pumice soils. The whole physiognomy of the Mamaku pumice forest gives one the impression of a young forest. Any one going to Rotorua can see for himself the truth of this, as the scenic reserve extending some miles along the railway frontage has been preserved from the sawmiller. The oldest of the trees are under one thousand years of age.

The Rotorua County may, as stated, be said to have been provided with a new soil several feet thick by the Rotorua pumice-shower. There are, however, a few exceptions to this statement. First and chiefly, the 1886 eruption of Mount Tarawera provided from that date a portion of the eastern side of the lake with a new and fundamentally different soil, known locally, from the fact of its having fallen in a plastic condition, as the "mud." This is the soil upon which rests the well-known Te Ngae Mission Farm. The farm has been worked for the past seventy years or more, and has a reputation for fertility and freedom from disease unequalled in the district. This mud-shower deposit thins out towards the Wairoa Road to the south of Te Ngae, but still influences the land there to its great advantage. There is no difficulty in rearing lambs to maturity on this mud country. Secondly, the rhyolitic breccia pillars or volcanic necks, so prominent a feature of the Mamaku landscape, by their erosion and decay provide a certain amount of top-dressing to the pumice in the immediate vicinity of such rocky outcrops. In some parts where this rhyolitic rock comes to the surface, so that the soil is formed from it in large areas, it forms a soil differing from that derived from air-borne pumice, and supports a different vegetation. This soil grows pasture which possibly does not induce bush sickness. The mechanical condition of the soil is different, containing more silt, fine silt, and clay than the pumice soil.

Mechanical condition of the soil is probably the primary cause of bush sickness. Coarse sandy soils suffer from many defects which tend to counterbalance any advantage in ease of working. Further, there is reason to believe that bush sickness is not confined to pumice lands or even volcanic lands in New Zealand, although, owing to the wide extent of these, the disease is able to run its course. It is suspected that bush sickness exists in a milder form on coastal sandy lands

* The pumice was formed in the volcano at a far earlier epoch than this, and may have undergone considerable weathering before its redistribution by a series of explosions, at which time, however, it was still a rock, not a soil.

or sand-dunes which have been grassed. The only obvious point of resemblance between sand-dunes and pumice lands is the coarseness of the soil-particles and the want of cohesion between them. The difficulty of diagnosing such malnutrition troubles in stock is great. Dune sandy lands exist in strips along the coast-line and abound in hollows or depressions often of considerable extent, and these contain soil of great fertility, having before drainage and improvement carried flax swamp or even white-pine forest. Naturally, the first thing a farmer would do on finding that his sheep were "not doing too well" on the hills—running at the eyes and becoming emaciated—would be to change them to an area growing better feed, where they would recover, and the trouble never becomes acute enough to obtain thorough investigation and recognition.

RHYOLITIC PILLARS OR NECKS, MAMAKU DISTRICT.

[*Photo by B. C. Aston.*

Cases which have been suspected to be akin to bush sickness, in that they could not be referred to any other malnutrition disorder or other disease, have come under notice from time to time in such widely separated sandy lands as those of Waikanae, Cape Farewell, and West Wanganui Inlet. The "coast disease" in King Island, Tasmania, may be something similar. Again, in Nairobi, British East Africa, on a volcanic-ash soil exists a wasting, non-transmissible disease in cattle, with no *post-mortem* lesions or pathogenic organisms, but evidence of extreme anæmia, which disappears when the animal is removed to a different type of soil or a *red* volcanic soil, and a complete recovery is made. The condition of the soil upon which bush sickness develops is always one of excessive aeration, judged by the excessive amount of pore-space. It appears that soils which give rise to malnutrition diseases in plants and animals—chlorosis and anæmia—are often soils of loose texture and coarse nature, and frequently are alkaline due to excess of carbonate of lime in the soil. It is significant that application of lime hydrate or carbonate as a top-dressing to pumice pasture-lands causes ruminants pastured thereon to become bush sick in a shorter time than they would on land not so treated. Although the grass of bush-sick country is not obviously chlorotic, observers have professed to detect a lighter shade of green in grass on pumice soil than that found on normal soils.

TABLE I.—CHEMICAL ANALYSES.

(Results, except *, are percentages on soil dried at 100° C.)

Laboratory No.	Locality.	Volatile Matter.			Total Nitrogen.	1-per-cent. Citric-acid Extract, Dyer's Method, Hall's Modification. ("Available" Plant-food.)					Hydrochloric-acid Extract. ("Total" Plant-food.)					Citric-acid Extract.
		*On Air-drying.	*At 100° C.	On Ignition.		Lime, CaO.	Magnesia, MgO.	Potash, K_2O.	Phosphoric Acid, P_2O_5.	Iron, Fe.	Lime, CaO.	Magnesia, MgO.	Potash, K_2O.	Phosphoric Acid, P_2O_5.	Iron, Fe.	Manganese, Mn.
PUMICE SOILS OF TYPICAL BUSH-SICK COUNTRY.																
M 226	Te Pu (unmanured grassland)	..	1·86	7·78	..	..	0·035	..	..	0·030	0·100	..	..	..	..	0·023
C 825/5	,, ,,	..	29·72	7·79	..	..	..	..	Trace	0·044	..	..	..	0·060	0·710	0·039
C 468/4	,, ,,	..	10·40	7·30	..	..	..	..	..	0·023	..	..	..	..	..	0·022
C 825/4	,, ,,	..	26·60	8·07	..	..	..	..	Trace	0·034	..	..	..	0·040	0·530	..
D 36/4	,, (limed)	.	27·69	7·55	0·260	0·156	..	0·010	0·017	..	..	..	..	0·060	0·830	..
M 223	Rotorua-Tauranga Road (cultivated)	..	1·22	5·63	..	..	..	..	..	0·046	..	.	..	..	..	0·021
M 224	,, (uncultivated)	..	..	..	..	..	..	..	..	0·030	..	..	..	..	..	0·023
L 94	Mamaku (unmanured) ,,	..	25·32	15·48	0·371	0·130	0·026	0·019	0·007	..	0·220	0·080	0·090	0·030	..	..
M 237	,, ,, ,,	..	14·24	10·42	..	0·140	0·017	..	..	0·042	..	..	..	..	..	..
C 825/3	,, ,, (recent burn)	.	48·67	20·71	..	..	..	..	Trace	0·064	..	..	..	..	..	..
D 348/1	,, ,, ...	..	36·14	12·25	0·254	0·131	0·018	..	0·006	0·067	0·413	..	..	0·070	0·970	0·017
D 348/2	,, (manured with iron) ..	..	38·46	17·68	..	0·122	..	0·017	0·005	0·064	0·367	..	..	0·058	0·910	..
M 251	Lichfield (cultivated) .. .	..	5·14	11·87	..	..	..	..	..	0·022	..	..	..	0·074	1·130	..
M 252	,, ,, ...	..	3·48	11·71	..	..	..	..	..	0·043	..	..	..	..	..	0·017
M 253	,, (virgin soil)	..	2·60	10·70	..	0·050	0·031	..	..	0·057	..	..	..	..	..	0·015
C 468/1	,, (control paddock) ..	..	12·00	13·30	..	..	..	..	..	0·030	..	..	..	..	..	0·021
D 348/7	,, ,, ..	..	34·68	12·68	..	0·074	..	..	0·008	0·023	0·389	..	..	0·130	0·830	..
C 1317/3	Lichfield (unmanured, but cultivated in past)	..	41·51	11·79	..	0·133	..	0·010	0·029	0·070	..	..	..	0·109	0·980	..
TYPICAL PUMICE SOILS OF COUNTRY NOT BUSH SICK.																
M 231	Ngongotaha (pasture in stumps, uncultivated)	..	5·04	23·31	..	0·035	0·017	0·027	..	0·315	..	..	..	..	..	0·027
C 825/7	Ngongotaha (river-terrace—pasture)	..	36·23	..	..	..	..	..	0·028	0·078	..	..	..	0·110	1·190	..
C 1064/4	Ngongotaha (lake-terrace—pasture manured with phosphate)	..	39·16	..	..	0·244	..	0·023	0·057	0·101	..	..	..	0·250	0·950	..
D 348/5	Ngongotaha (swampy land near lake-level—rough pasture)	..	35·84	10·34	..	0·158	..	0·013	0·011	0·102	0·445	..	..	0·120	0·810	..
D 348/6	Ngongotaha (another locality, similar to 348/5—rough pasture)	..	35·20	6·68	..	0·045	..	0·009	0·007	0·129	0·204	..	..	0·100	0·850	..

TABLE 1.—CHEMICAL ANALYSES—*continued.*

(Results, except *, are percentages on soil dried at 100° C.)

Laboratory No.	Locality.	Volatile Matter.			Total Nitrogen.	1-per-cent. Citric-acid Extract. Dyer's Method. Hall's Modification. ("Available" Plant-food.)					Hydrochloric-acid Extract. ("Total" Plant-food.)					Citric-acid Extract.
		On Air-drying.	*At 100° C.	On Ignition.		Lime, CaO.	Magnesia, MgO.	Potash, K_2O.	Phosphoric Acid, P_2O_5.	Iron, Fe.	Lime, CaO.	Magnesia, MgO.	Potash, K_2O.	Phosphoric Acid, P_2O_5.	Iron, Fe.	Manganese, Mn.
NON-PUMICE SOILS, ROTORUA DISTRICT—NOT BUSH SICK.																
C 1317/4A	Te Ngae (1886 eruption mud—pasture)	..	24·74	4·67	..	0·186	..	0·016	0·044	0·135	..	..	..	0·096	1·540	..
D 36/5	,, ...	..	21·25	5·36	..	0·192	..	0·017	0·047	0·240	..	..	..	0·094	1·420	..
D 36/6	Wairoa Road (tutu and fern) ..	..	26·65	5·44	..	0·146	..	0·023	0·031	0·181	..	..	..	0·080	1·310	..
D 1121/13	Te Ngae (white-pine swamp) ..		23·89	3·51	0·066	..	.	0·020	0·025	0·178	2·050	0·760	0·110	0·050	0·803	..
D 1121/14	,, (hillside fern land) .	.	17·76	3·09	0·096	..	..	0·023	0·022	0·101	1·740	0·800	0·270	0·050	1·598	..
C 1317/5	Reporoa (drained swamp) ..	..	71·36	48·81	..	0·252	..	..	0·070	0·300	..	..	..	0·331	0·038	..
C 1317/9	,, ,, ..	..	46·34	21·04	..	0·243	..	0·043	0·120	0·222	..	..	..	0·150	18·150	..
C 348/9	Onuku, near Lake Rerewhakaitu ..	..	5·30	..	..	0·142	..	0·013	0·008	0·088	1·539	..	..	0·084	2·040	..
SOILS NOT IN PUMICE DISTRICT—FOR COMPARISON.																
D 1123/2	Motuihi Island, Auckland; windmill paddock (greywacke soil; ratstail grass)	..	20·22	11·12	0·312	..	..	0·015	0·003	0·156	0·740	0·790	0·180	0·110	3·175	.
D 1123/1	Motuihi Island, Auckland; behind windmill paddock	..	22·20	12·06	0·319	..	..	0·016	0·003	0·131	0·650	0·730	0·120	0·080	3·026	.
D 1124/1	Hauraki Plains Shelly Beach) ..	..	44·40	16·44	0·481	..	..	0·033	0·000	0·227	0·450	0·100	0·370	0·240	3·304	..
D 1124/2	,, (clay paddock) ..	..	39·01	19·87	0·597	.	.	0·100	0·002	0·273	0·370	0·850	0·330	0 210	3·000	..
D 1124/3	,, Piako River ..	.	37·99	15·08	0·422	.	..	0·056	0·032	0·324	0·420	0·880	0·330	0·140	2·542	..

TABLE 2.—MECHANICAL ANALYSES.

(Results are percentages on air-dried soil.)

Laboratory No.	Description of Soil. (Classification of United States Department of Agriculture, modified.)	Analysis of "Fine Earth" passing 2 mm. Sieve.						Stones and Gravel.
		Fine Gravel.	Coarse and Fine Sand.	Silt.	Fine Silt.	Clay.	Moisture and Loss on Ignition.	
PUMICE SOILS OF TYPICAL BUSH-SICK COUNTRY.								
L 94	Coarse sandy soil	0·7	40·8	18·0	3·5	2·8	33·9	4·0
C 468/4	,, ...	23·3	53·4	10·9	2·4	..	9·3	..
C 825/4	,, ...	20·8	56·8	9·1	2·6	..	10·5	..
C 468/1	Fine sandy soil	2·0	41·3	32·9	5·7	..	16·3	..
D 36/4	Coarse sandy soil	13·4	50·3	12·2	2·9	0·8	19·1	..
D 348/7	Fine sandy soil	1·0	39·2	34·7	7·2	..	16·0	..
TYPICAL PUMICE SOILS OF COUNTRY NOT BUSH SICK.								
C 825/7	Fine sandy soil	Nil	50·8	24·6	6·1	..	17·3	..
R 979	Medium sandy soil.. ..	2·6	31·2 23·9	18·5	6·2	0·9	13·9	Trace.
NON-PUMICE SOILS, ROTORUA DISTRICT—NOT BUSH SICK.								
D 348/9	Clay loam	0·60	12·35 19·88	20·95	13·66	25·59	2·08 2·45	..
C 1317/4A	Fine sandy soil	5·47	22·80 35·09	15·01	8·10	6·00	1·49 4·39	..
R 1096*	,, ...	6·10	18·30 26·60	18·70	13·40	5·50	2·20 9·70	5·5

* Wairoa Road—for completing D 36/6.

Concerning the chemical composition of the rock from which the Rotorua pumice is derived—rhyolite—this is an acidic (containing a preponderance of acid) volcanic rock, which is naturally low in iron content compared with other volcanic rocks of more basic character (containing more bases or metallic oxides), such as the andesites, basalts, &c. Rhyolite has the same chemical composition as granite, a little over 1 per cent. of iron being present, whereas more basic rocks may contain two or three times this quantity, and basalts as much as 10 per cent. or more. Naturally, the soil derived from a rhyolitic pumice is lower in iron than a soil from a rock richer in iron. It should be remembered that there are different kinds of pumice, and the composition of it is, of course, dependent on the rock from which it is derived. There is, for instance, in Taranaki an andesitic pumice which should contain 8 per cent. of iron. To say that a rock is a pumice—which merely means a volcanic froth—conveys nothing of its composition to a geologist. In these papers, where the distinction is made between pumice soils and rhyolite soils, it must be understood that although both are rhyolites, the pumice soils are derived from the Rotorua pumice-shower, and the rhyolite from the underlying country rock, which is a rhyolite or rhyolitic breccia (a solidified paste of volcanic fragments).

Space limitations dictate that for the present only a small number of soil-analyses can be inserted, according to the accompanying tables. In an attempt to determine what amounts of iron are present as available iron in the soil recourse has been had to the well-known Dyer's method of determining available plant-food in soils. This method extracts iron in much greater amounts than it does other plant-foods,

but no standard has been suggested for iron, and there is no reason why the standard figure should not be a high one compared with those for the other mineral foods—potash and phosphoric acid. The fact remains that the figures for "available" iron in the above analyses of bush-sick soils are much lower on the whole than those for pumice soils upon which bush sickness does not develop, yet both soils have had a common origin, although the subsequent history of one has been different from that of the other. When one turns to non-pumice soils much greater amounts of iron are found, whether these soils be in the midst of the pumice area or whether in areas quite apart. The whole question of the probable influence of iron in bush sickness is so important that a full discussion must be reserved for another number.

(To be continued.)

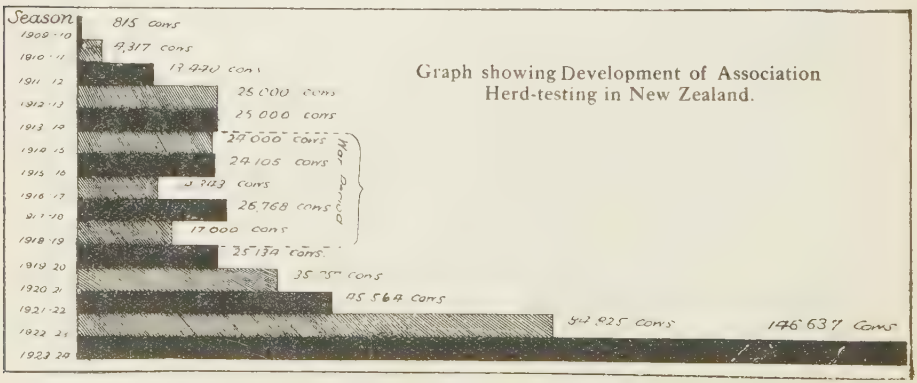
DAIRY-HERD-TESTING ASSOCIATIONS.

DEVELOPMENT IN 1923–24 SEASON.

W. M. SINGLETON, Director of the Dairy Division, Wellington.

THE close of the cow-testing season always invites retrospect—a survey of results, a comparison with the work done in previous years, and an estimate of the position. As was the case in the 1922–23 season, an effort was made to ascertain the number of cows in the Dominion which have been systematically tested on the herd-testing-association principle, and it is pleasing to record that the figures for 1923–24 disclose an increase over the previous season of no less than 73 per cent. The aggregate at date of writing has reached 146,637 cows, as against 84,825 for 1922–23.

To enable readers to see at a glance the progress made since the first association was inaugurated, in the spring of 1909, the accompanying graph has been prepared. There is probably no need to state



that the erratic numbers around the middle years represented were the result of the Great War's influence on labour and general conditions.

The following table gives the figures for the 1923–24 season, and indicates how the movement is represented in the various land districts. The numbers of cows shown in such districts are those of the Agricultural and Pastoral Statistics taken as at 31st January, 1923—the latest available.

Land District.	Number of Dairy Cattle.	Number of Cows tested.	Percentage of Cows tested.	
			1923–24.	1922–23.
North Auckland	185,876	14,395	7·74	7·36
Auckland	292,520	70,934	24·25	14·35
Gisborne	27,248	3,082	11·31	10·12
Hawke's Bay	50,361	4,391	8·72	3·75
Taranaki	201,758	17,807	8·83	8·34
Wellington	193,815	29,944	15·45	7·29
North Island	951,578	140,553	14·77	9·59
South Island	297,065	6,084	2·05	0·78
Dominion	1,248,643	146,637	11·74	7·46

Of the total of 146,637 cows, officers of the Dairy Division have controlled the testing of 37,378.

The foregoing figures appear very creditable—as they certainly are, but it must be remembered that the cows on test represent only about 12 per cent. of the total number of dairy cows in the Dominion. There is therefore still considerable progress required before the number systematically tested reaches a satisfactory proportion of our dairy-cow population. The number of associations represented is 182 (compared with 137 in 1922–23), and most of these are connected with dairy companies to which the members are suppliers. There are 535 dairy factories in New Zealand, and we consider that the time is coming when herd-testing for yield will be represented among the suppliers to every factory.

As was the case in the previous season, the fact which attracts attention so far as the present statement is concerned is the paucity of cows tested in the South Island. In Otago and Southland alone there are ninety-seven dairy factories, with 114,706 cows supplying them. Yet the whole of the South Island tested less than six thousand cows, and even of these cows 2,038 were tested by officers of the Dairy Division. It would be satisfactory to see South Island dairy-farmers take a more active interest in testing—because the benefits affect first of all their own incomes and afterwards the country as a whole—and to find next season bringing forward many new cow-testing associations in that part of the Dominion, each with a satisfactory membership. It is recognized, of course, that some districts are more suited for dairying than others, and that the North Island specializes more in dairy-farming than the South. At the same time we firmly believe that the suppliers to every dairy factory should have an arrangement whereby their cows are systematically tested.

THE OFFICIAL SEED-TESTING STATION.

RECORD OF OPERATIONS IN 1923–24.

NELSON R. FOY, Seed Analyst, Biological Laboratory, Wellington.

THE work of the Department's seed-testing station, at Wellington, was well maintained during the twelve months ended 31st March, 1924, 9,100 samples being tested for germination and 1,526 for purity, compared with 9,056 and 1,500 respectively handled during the previous year. Some 600 miscellaneous laboratory tests were also made in 1923–24. As usual the great bulk of the routine testing was of samples forwarded by the seed trade, only some 120 samples having been received from farmers. This points to confidence in the ability and desire of the trade as a whole to supply good seed. Many firms now furnish germination figures with parcels of seed, and in most cases farmers who buy questionable seed or deal with other than reputable houses have only themselves to blame for any bad results.

The movement of seed-testing throughout the year is shown in Table 1. Two periods of special activity are indicated—one in July and August, representing preparations for spring sowings and stock-takings; the other in February and March, representing the new season's grasses and clovers.

The number of samples received of the various species (Table 2) is of interest in that it shows where lie the greatest activities of the seed-trade in New Zealand. The small number of cereal samples tested is rather surprising, and suggests that more attention might be paid by farmers to the viability of their cereal seeds.

GRASSES.

The purity and germination of the main species of grasses tested at the station, together with their main impurities, are shown in Tables 3 and 4, which furnish many points of interest.

Perennial Rye-grass.—The average germination of 81 per cent. may be considered very satisfactory. The average growths of the seed from the different rye-grass districts were as follows: Poverty Bay, 93 per cent.; Hawke's Bay, 92·7; Sandon (Manawatu), 80·5; Canterbury, 87·4; Southern, 80·1. This season's (1924) Southern, Canterbury, and Sandon seed shows a distinct improvement on last year's figures, the extremely dry harvesting season apparently being in its favour. A total of forty species of impurities were found in the samples generally, the chief among them being hair-grass, goose-grass, and catsear, which are among the commonest of the undesirables in our pastures. Ergot was present in the season's seed to a greater extent than is usual. Two samples of seconds contained Californian thistle.

Table 1.—Number of Samples received throughout the Year.

Month.	Number.	Month.	Number.
1923—April	589	1923—October	648
May	829	November ..	574
June	912	December ..	462
July	978	1924—January	478
August	1,214	February	774
September	796	March	846

Table 2.—Number of the various Species tested.

Lucerne	97	Cocksfoot	610
Alsike	74	Paspalum	34
White clover	325	Poa pratensis	46
Cow-grass and red clover ..	405	Prairie-grass	21
Crimson clover	35	Other grasses	160
English trefoil	34	Japanese millet	40
Lotus major	63	Oats	42
Other clovers	36	Other cereals	18
Perennial rye-grass	1,537	Mangolds	184
Italian rye-grass	370	Turnips	413
Western Wolths	201	Swedes	278
Timothy	76	Rape	145
Crested dogstail	90	Kale	48
Danthonia spp.	81	Tree-seeds	16
Brown-top (*Agrostis tenuis*) ..	78	Flower seeds	20
Chewings fescue	524	Vegetable seeds (other than peas)	325
Meadow fescue	35	Peas	179
Meadow foxtail	43	Other leguminous herbage plants	26

Table 3.—Percentage of Purity and Germination of Grasses.

	Average Percentage of Impurities.	Percentage of Samples containing Noxious Weeds.*	Percentage of Germinations.			Percentage of Samples germinating between					
			Highest.	Lowest.	Average.	0–50 %.	51–60 %.	61–70 %.	71–80 %.	81–90 %.	91–100 %.
Perennial rye-grass ..	0·8	1·5	100	0	81·1	4·0	4·0	10·7	24·8	33·3	23·3
Italian rye-grass ..	0·2	..	99	14	80·4	2·0	2·5	7·5	18·6	24·2	50·4
Western Wolths ..	0·5	5·0	100	21	80·2	6·2	5·6	4·8	11·2	20·4	53·2
Timothy	0·3	0·5	100	46	94·0	1·2	..	..	4·6	11·3	84·7
Crested dogstail ..	1·0	10·0	100	3	89·6	2·1	2·3	3·9	5·3	15·2	73·4
Cocksfoot	1·7	7·0	98	0	67·3	13·2	12·3	27·3	28·6	14·9	6·6
Brown-top†	3·6	7·0	89	39	81·6	4·0	10·2	8·6	14·7	36·4	26·8
Chewings fescue ..	1·1	6·0	100	1	86·4	2·1	2·0	4·6	10·5	29·6	52·3
Meadow fescue	..	..	97	2	60·2	40·0	2·8	2·8	14·2	17·0	22·8
Poa pratensis	0·5	2·0	83	14	55·2	3·6	34·0	26·2	13·3	3·9	..
						0–20 %.	21–30 %.	31–40 %.	41–50 %.	51–60 %.	61–100 %.
Meadow foxtail	..	..	63	3	31·3	23·2	25·5	34·9	11·6	4·6	..
Danthonia spp.	13·5	1·5	81	1	39·2	24·0	16·4	18·6	18·0	10·5	15·5
Paspalum	..	..	59	0	24·5	54·2	20·8	6·5	7·4	3·5	6·0

* Those species mentioned in the Act, other than docks and sorrel.
† Average percentage of husk, 34·0—highest, 70·0; lowest, 8·7.

Table 4.—Occurrence of the Main Impurities of the Grasses.

(The figures are percentages of samples in which the various impurities occurred.)

	Perennial Rye-grass.	Italian Rye-grass.	Western Wolths.	Timothy.	Crested Dogstail.	Cocksfoot.	Brown-top.	Chewings Fescue.	Danthonia Spp.
Hair-grass	72	74	73	..	14	11	25	41	100
Goose-grass	53	60	74	..	..	61	..	11	29
Catsear	30	15	10	..	42	30	40	88	36
Perennial rye-grass ..	..	..	..	..	70	89	8	66	43
Sweet vernal	8	3	6	..	38	5	23	36	57
Rib-grass	15	15	20	25	14	42	41	1	36
Yorkshire fog	11	7	14	10	74	46	14	54	38
Sorrel	24	34	47	50	4	18	32	17	2
Curled dock	5	3	6	..	..	18	4	1	4
White clover	15	12	14	50	15	12	40	6	7
Creeping buttercup ..	2	3	..	..	..	14	..	..	1
Californian thistle ..	1	2	6	..	8	..	..	1	..
Hawkweed	..	..	..	..	10	..	4	..	..
Ergot sclerotia	31	24	7	10	15	7	68	9	..
Oxe-eye daisy	..	..	..	..	1	2	..	..	..
Cocksfoot	14	5	..	..	1	..	4	16	6
Fat-hen	..	..	7	25	..	3	..	..	..
Italian rye-grass	62	..	..	..	..	2	..	..	10
Suckling clover	19	26	40	..	14	2	19	3	4
Crested dogstail	21	10	..	10	..	2	23	10	2
Chickweed	..	3	7	..	22	2	..	1	..
Field madder	2	5	6	..	..	1	..	..	..
Alsike	7	3	1	100	4	..	..	1	2
Lotus spp.	1	..	..	..	1	..	80	..	2

Italian Rye-grass and Western Wolths.—The remarks concerning the germination and purity of perennial rye-grass apply equally to Italian and Western Wolths. Californian thistle was found to a greater extent than in perennial rye-grass. Italian contained twenty-eight species of impurities and Western Wolths twenty-two.

Timothy.—Practically all imported timothy seed was of good quality and unusually free from harmful impurities. Some excellent samples of seed grown in Southland were received. Timothy contained only twelve species of impurities, the chief of which were alsike and sorrel.

Crested Dogstail.—An average growth of 90 per cent. is very satisfactory. Last season's seed was of excellent quality, more than 70 per cent. of the samples germinating over 90 per cent. (average 97 per cent.) This season's southern seed is not so good, the dry season evidently "ripening" the seed off before it had fully matured. Early in the season most of the seed failed to grow much over 60 to 70 per cent., but maturity is now complete and the seed gives an average growth of 86 per cent. It is of a light canary-yellow colour (so desired by many farmers), in contrast to the dark coppery colour of really good dogstail. Rye-grass, Yorkshire fog, sweet vernal, and catsear were the main impurities. Californian thistle was found to be present in some of the samples, but it is not so common as it was some years ago. Dogstail contained thirty-seven species of impurities.

Danthonia spp.—An average of 39 per cent. germination is only fair for Danthonia. Most of the samples were of D. pilosa, although nearly all contained the smaller D. semiannularis in varying quantities, from 1 per cent. to 50 per cent. All the samples contained hair-grass from 2 per cent. up. One sample received, labelled "Danthonia," consisted of D. pilosa, 2 per cent.; hair-grass, 97 per cent.; and other extraneous seeds, 1 per cent. Sweet vernal, rye-grass, rib-grass, and catsear were the chief additional impurities. Many samples contained from 5 per cent. to 15 per cent. of inert matter (straws, &c.), a good deal of which could easily be dressed out. Danthonia contained only thirteen species of impurities.

Brown-top (*Agrostis tenuis*).—An average growth of 81 per cent. is good for brown-top. Much of this seed is sold in a rough unblown state, while the germination tests are made on fully developed mature seed. Quantities of seed of excellent quality are now being saved in Southland, and this it is hoped will attract attention in foreign markets. Waipu brown-top contained an average percentage of 34 per cent. of husk, with a maximum of 70 per cent.; southern seed contained 5 to 10 per cent. The percentage of impurities is also much lower in southern, the heavy-weighing Lotus spp. of the northern seed being entirely absent. The chief impurities of Waipu seed are the Lotus spp. (mainly L. major and L. hispidus), rib-grass, white clover, catsear, and sweet vernal; and those of southern seed small percentages of yarrow, and mouse-eared chickweed. Brown-top contained twenty-four species of impurities.

Chewings fescue.—The season's Chewings fescue (average germination 86·4 per cent.) was of good average quality. Last season's seed was particularly above the average, and constituted one of the finest crops taken from Southland for many years. This season's seed is not so good, and the indications are that it will not stand shipping overseas as well as did that of 1923. On the other hand, 1924 seed is cleaner; being harvested early it missed the seeding of the later flowering catsear—the "price dropper" of Chewings fescue. Catsear occurred in nearly 90 per cent. of the samples, while rye-grass, Yorkshire fog, and hair-grass were the additional most common impurities among the twenty-nine species met with. Californian thistle was found to be present in a few samples, but only to a limited extent.

Cocksfoot.—An average growth of 67 per cent. can be taken as being very satisfactory. Considerable quantities of Danish seed were imported during the year. This seed gave varying germination results, ranging from 10 per cent. to 97 per cent., with an average of 73 per cent. It would appear that much of the lower grade seed was being dumped from an overloaded overseas market. Of the colonial seed Akaroa gave an average of 67 per cent., and Plains (Canterbury) an average of 78 per cent. Of the whole of the cocksfoot tested 97 per cent. contained empty glumes. The percentage (by numbers) ranged from 1 per cent. to 85 per cent., and 8·5 per cent. of the samples contained over 20 per cent. of empty glumes, the average being 10·4 per cent. Cocksfoot contained fifty-seven species of extraneous seeds, the chief of which were: New-Zealand-grown—rye-grass, Yorkshire fog, goose-grass, rib-grass, and catsear; imported (in addition to those mentioned for New

Zealand)—Creeping buttercup, field foxtail, night-flowering catchfly, tall fescue, and field chamomile. A few of the imported samples (2 per cent.) contained ox-eye daisy.

Paspalum dilitatum.—An average growth of 24·5 per cent. for Paspalum is only fair. Over 50 per cent. of the samples germinated under 20 per cent. and 6 per cent. over 60 per cent. Most of the seed was of Australian origin, and the new season's seed now coming on to the market is giving some very fine results—much of it being over 50 per cent. growth. New Zealand seed is very poor, and is mainly responsible for the low germination percentage. No purity tests were made.

Poa pratensis.—All imported seed was of fair average quality. Eleven species of weed seeds occurred, the chief of which were white clover, sorrel, mouse-eared chickweed, and sedge species.

Other Grasses (Table 2) include red-top (86 per cent. average germination), yarrow (84 per cent.), Indian Doob (84 per cent.), tall oat-grass (75 per cent.), Poa trivialis (85 per cent.), and Yorkshire fog (90 per cent.).

CLOVERS AND OTHER LEGUMES.

The percentage of purity and germination of the main clovers and other leguminous herbage plants is shown in the following table:—

Table 5.—Percentage of Purity and Germination of the Main Clovers, &c.

	Average Percentage of Impurities.	Percentage of Samples containing Noxious Weeds.	Percentage of Germination.			Percentage of Samples germinating between					
			Highest.	Lowest.	Average.	0–50 %.	51–60 %.	61–70 %.	71–80 %.	81–90 %.	91–100 %.
White clover	4·2	25·0	100	10	88·3	3·7	1·8	1·8	4·9	32·6	55·0
Alsike..	0·9	25·0	98	13	87·0	2·7	2·7	4·0	8·0	23·0	60·0
Cow-grass	0·6	30·0	100	8	90·8	2·3	1·0	1·6	1·8	16·9	76·3
Lucerne	0·1	..	100	51	91·6	..	2·2	1·1	7·7	25·2	63·7
English trefoil	0·6	..	97	4	67·2	21·2	9·9	12·1	12·1	12·1	33·3
Crimson clover	1·2	2·0	100	7	84·1	6·3	6·3	3·2	6·3	6·3	71·0
Lotus major	9·2	25·0	99	38	78·5	3·2	16·0	11·1	19·0	31·7	19·0

White Clover.—An average germination of 88·3 per cent. can be considered good. More than half of the samples germinated over 90 per cent., and the germination of the majority of those samples growing between 80 and 90 per cent. was lowered by the hard-seed content. The highest percentage of hard seeds was 43, and the average for the whole of the samples tested was 10 per cent. Sixty-two species of extraneous seeds occurred in white clover. Of these the main ones were suckling clover (occurring in 94 per cent. of the samples), alsike (82 per cent.), sorrel (81 per cent.), rib-grass (75 per cent.), cow-grass (68 per cent.), fat-hen (42 per cent.), haresfoot trefoil (35 per cent.), and scarlet pimpernel (30 per cent.). Dodder occurred in 5 per cent. of the samples examined; the highest rate of occurrence was 2,000

seeds per pound, and the lowest five. In only four samples did the amount of dodder exceed 100 seeds per pound. The highest percentage of impurities was 49 per cent., composed mainly of suckling clover and sorrel.

Alsike.—The average germination was 87 per cent., the samples being mainly of imported seed. The percentage of hard seeds—5 per cent.—was lower than that of white clover. Twenty species of impurities were found in alsike, the chief of which were white clover (in 87 per cent. of the samples), English trefoil (87 per cent.), Timothy (86 per cent.), cow-grass (50 per cent.), suckling clover (25 per cent.), and Californian thistle (12 per cent.).

Cow-grass and Red Clover.—The average germination was 90·8 per cent. The bulk of this seed was of colonial origin, only a few imported lines being examined. The New Zealand seed was of a much finer type and very much cleaner than the imported. The highest percentage of hard seeds was 51 per cent., and the average 5 per cent. Fifty-eight species of impurities were found, including rib-grass (in 91 per cent. of the samples), white clover (50 per cent.), alsike (26 per cent.), curled dock (28 per cent.), sorrel (28 per cent.), and fat-hen (20 per cent.). Californian thistle occurred in 4 per cent. of the samples, and dodder in 6 per cent. These two impurities were found only in imported seed, at the average rate of 40 seeds per pound.

Lucerne.—Seed germinated very well on the average, and contained very few impurities. Nine species of impurities occurred, the main ones being rib-grass (in 75 per cent.), cow-grass (62 per cent.), fat-hen (38 per cent.), and Melilotus spp. (25 per cent.). This last-named is taken as an indicator for Marlborough seed. Lucerne contained on the average 5 per cent. of hard seeds. Dodder did not occur in any of the samples.

English Trefoil.—This seed did not grow well, showing an average of 67·2 per cent., with only 1 per cent. of hard seeds. Seven species of impurities occurred, the chief being rib-grass, red clover, field madder, and the cranesbills.

Crimson Clover.—The samples tested were either very low or very high, there being no intermediate lines. Hard seeds were entirely absent. Thirty-one species of impurities occurred, twenty-three of which were found in one sample. English trefoil (in 60 per cent.), field madder (60 per cent.), sorrel (50 per cent.), cut-leaved cranesbill (40 per cent.), and night-flowering catchfly (25 per cent.), were the principal species. Dodder did not occur, and Californian thistle was found in one sample only.

Lotus major.—An average growth of 84·1 per cent. can be considered satisfactory for this seed. The samples contained on an average 20 per cent. of hard seeds, with a maximum of 75 per cent. Only 6 per cent. of the samples did not contain hard seeds. Thirty-seven species of impurities occurred, with the rather high average percentage of 9·2. Nearly one-half of the samples contained L. hispidus (L. angustissimus of the seed-trade), from 1 per cent. to over 50 per cent. The chief impurities were white clover (in 100 per cent.), rib-grass (84 per cent.), sorrel (75 per cent.), suckling clover (75 per cent.), sweet vernal (75 per cent.), selfheal, spurrey, Yorkshire fog (50 per cent.), and dodder (25 per

cent.). Practically all the samples containing dodder were of imported seed, which, although it does not contain the other Lotus spp., is always more impure than colonial seed. One sample examined contained dodder at the rate of 91,000 seeds per pound, which must be considered a record for dodder content so far as this station is concerned. Some of the finest Lotus major which has ever come under the notice of the writer has been produced in Southland this season. It is practically pure, well formed, and of a beautiful colour.

Other Clovers, &c. (Table 2), include strawberry clover (80·6 per cent. average germination), subterranean clover (65 per cent.), Berseem clover (90 per cent.), suckling clover (70 per cent.), Lotus hispidus (77 per cent.), L. corniculatus (60 per cent.), sainfoin (35 per cent.), serradella (65 per cent.), King Island melilot (65 per cent.), and sand clover (75 per cent.).

ROOTS AND CRUCIFEROUS FORAGES.

The following table shows the percentage of germination of the main roots and cruciferous forage plants.:—

Table 6.—Percentage of Purity and Germination of the Main Roots and Cruciferous Forage Crops.

—	Percentage of Impurities.	Percentage of Germination.			Percentage of Samples germinating between					
		Highest.	Lowest.	Average.	0–50 %.	51–60 %	61–70 %.	71–80 %.	81–90 %.	91–100 %.
Turnips ..	0·1	100	13	90·2	2·8	2·4	3·7	7·0	20·0	64·0
Swedes ..	0·1	100	2	84·5	3·7	2·5	6·6	16·4	22·7	47·9
Rape ..	0·1	100	35	91·4	2·6	1·3	2·6	2·0	16·0	75·3
Kale ..	0·1	100	39	89·8	4·1	4·1	..	4·1	25·0	62·5
					1–50 %.	51–100 %.	101–150 %.	151–200 %.	201–250 %.	251–300 %.
Mangolds ..	0·1	249	43	151·1	0·9	13·5	48·3	34·8	2·4	..

Turnip and Swede Turnip seed germinated very well, giving an average of 90 per cent. Swedes were a little lower—84·5 per cent.—which can be considered a fair average. Both these seeds are always very pure and contain only small percentages of cleavers and bindweed. Several graphited lines were noticed, but in all cases the seed was true to label. The mixing of very old with new seed was also found to be not uncommon.

Rape seed gave the satisfactory average growth of 91·4 per cent. Impurities were as for turnips and swedes.

Kale seed is usually not so vigorous as rape, &c., so that 89·8 per cent. can be considered a very good average result. Impurities were also as for turnips.

Mangolds.—An average of 151·1 per cent. is very satisfactory. Less than 15 per cent. of the samples germinated under 100 per cent. (Germination of mangolds is expressed in terms of the number of seedlings

per 100 clusters.) Few impurities were noticed—cleavers, curled dock, and bindweed being the main ones.

Carrots gave the fair average germination of 70 per cent.

MISCELLANEOUS FORAGES.

Average germinations of those tested were: Japanese millet, 92 per cent.; maize, 90 per cent.; sorghum, 70 per cent.

CEREALS.

Average germinations recorded were as follows: Oats, 85 per cent.; barley, 84 per cent.; wheat, 88 per cent.; ryecorn, 90 per cent.

PEAS, BEANS, AND TARES.

All these seeds germinated well, the respective averages being 93, 92, and 90 per cent. All the peas and beans tested were colonial grown, and were of excellent quality and appearance. A few very poor samples of tares and vetches were received.

VEGETABLES.

Over thirty varieties (325 samples) of vegetables seeds were tested and, with the exception of a few obviously old lines, all gave good results.

PASTURE MIXTURES.

Over twenty of these mixtures were tested and examined during the year. The majority were forwarded by farmers who had failed to obtain a strike. On the whole, the results tended to show that the fault did not lie with the seed. Some of the samples, however, were of the "auction-room" variety, and were actually worth much less than the low price paid for them. One "bargain" made by a farmer at 5d. per pound gave the following analysis:—

	Percentage of Sample.	Germination Percentage.
Rye-grass	10	56
White clover, cow-grass, alsike	5	74 (average).
Cocksfoot, dogstail, Poa pratensis	5	42 (average).
Rib-grass	65	..
Other weed-seeds (35 species)	15	..
	100	

The value of the useful seed (20 per cent.) present was actually less than 2d. per pound. It is well that lines such as this are rare. The strange part of it is that there are always willing purchasers for such seed.

CONCLUSION.

On comparing the foregoing data with those of a similar nature of other countries it is evident that the seed handled by the New Zealand trade is of a high standard in general, and that it is the honest endeavour of the majority of our seed-merchants to supply the best.

NOTE.—Credit is due to Mr. W. J. Cooch, of the seed-station staff, for the compilation of most of the figures used in this article.

THE BEST STAGE FOR CUTTING WHEAT.

FURTHER EXPERIMENT AT LINCOLN.

J. W. CALDER, B.Ag., Canterbury Agricultural College, Lincoln.

LAST year Dr. F. W. Hilgendorf and the writer made a determination, by the statistical method, of the earliest stage at which wheat could be cut without loss of weight by shrivelling, the result being recorded in this *Journal* for June, 1923. That stage was the one denominated "C" in the trials referred to.

This year the trial was repeated on the same plan, using a crop of College Hunters in place of the Solid-straw Tuscan. The indications given last year were so plain that it was considered sufficient on this occasion to observe only stage C, and those immediately previous to and following it, omitting the extreme stages A and E. The result of the weighings was as follows:—

Average Weight of 100 Grains of Wheat cut at different Stages of Ripeness.

Stage B	4.645 ± 0.028 grammes.
Stage C (three days later than B) ..	4.794 ± 0.038 grammes.
Stage D (three days later than C) ..	4.790 ± 0.041 grammes.

This is exactly the result obtained last year. The difference between the weights of 100 grains cut at stages B and C is 0·149 grammes, and the "probable error" of that difference is 0·047 grammes. Since the difference is more than three times the probable error, we have a forty-to-one chance that the difference is a real one and not due to the vagaries of sampling. The difference in weight between stages C and D is less than the probable error, and therefore is only such a difference as might be expected from various samples of the same material. We thus conclude with certainty that the crop increases in weight up to stage C—that cutting before that leads to loss by shrivelling, while waiting after that results in no gain in weight but only in risk of loss by shaking.

The method of the experiment, and the use of the "theory of probabilities," were explained in more detail in the former article.

Stage C is thus described: General aspect of the crop ripe-coloured, but close scrutiny revealed a tinge of green. Straws all yellow except about 1 per cent., which showed 3 in. of green above the topmost knot. Knots all green. Heads all ripe-coloured except about 1 per cent. still green. Grains in the riper heads so firm that no kind of milk or dough could be squeezed out of them, but soft enough to cut easily with the thumb-nail.

The interest of the experiment is not merely that it defines exactly the stage at which wheat should be cut. It confirms last year's trial, and emphasizes the utility of the statistical method of investigating agricultural experiments, even when these are concerned with abstruse questions involving elusive differences.

TESTING OF NEW-ZEALAND-GROWN WHEATS.

A FURTHER SERIES OF SAMPLES.

L. D. FOSTER, Analyst, Chemistry Section, Wellington.

I. MILLING-QUALITIES.

A FURTHER series of wheat-samples has recently been tested at the Department's Chemical Laboratory, and the milling-qualities of the various wheats determined. Work on the strength or quality of the flours obtained is proceeding.

The samples received differed considerably from those tested last year,* many being of lesser known varieties. Six samples of Velvet and about a dozen of the different Tuscans were received. On the other hand, a number of samples of interesting varieties were obtained from different sources; the majority of these came from the Ashburton Experimental Farm. No samples were received from Tuapeka and the Upper Taieri, districts which previously have sent in excellent wheats. Three samples of Yeoman were obtained. This variety is a comparatively new wheat which is gaining a certain amount of popularity in England on account of its good all-round qualities. According to the "Interim Report on Cereals, Bread, and Flour" (Ministry of Agriculture and Fisheries, London, 1923), Yeoman crops heavily on typical wheat soils, possesses a good straw, and, above all, possesses strength sufficient to permit the miller to make good bread-flour from it without the admixture of foreign wheat. Since climatic conditions in England and parts of New Zealand are somewhat similar, it is possible that Yeoman grown here may retain those qualities which are enabling it to compete favourably in England with the strong wheats imported from Canada and elsewhere. Among the other wheats are several which are said to possess good strength when grown in the country of their origin.

This year the weight per bushel has been calculated, and should prove of interest when compared with the other properties of the different samples. These calculated weights are relative only, though care has been taken to make them as accurate as possible.

It will be noticed from the accompanying tabulated statement that some of the varieties were harvested in 1923 and some during the current year. Since wheats and flours improve in strength and baking-qualities when stored even up to three and four years, it is necessary to keep this in mind when comparing the different seasons' samples. It is not known whether the yield of flour of local wheats is affected by storage beyond a reasonable length of time.

Some of the wheats were more difficult to mill than is usually the case. As this defect was confined to the samples collected from the 1923 harvest, it would appear that it was due to some peculiarity in the climatic conditions of that wheat-growing season. As each variety

* See *Journal* for July, August, and September, 1923.

Table I. Milling Tests of New Zealand-grown Wheats (Second Series).

Laboratory No.	Variety.	Where grown.		Year harvested.	Date of Milling.	Calculated Weight per Bushel.	Milling Test.			Remarks on Yield of Flour.
		Locality.	County.				Bran.	Pollard.	Flour.	
						lb.	Per Cent.	Per Cent.	Per Cent.	
R 1200	Velvet	Ashburton ..	Ashburton ..	1924	16/4/24	642	11·6	15·3	73·1	Very good.
R 1189	,, ...	,, ..	,, ..	1924	4/4/24	62	8·1	19·0	72·9	Good.
R 537	,, ...	Pukeuri ..	Waitaki ..	1923	22/3/24	63	10·4	17·1	72·5	,,
R 1201	,, ...	Lincoln ..	Springs ..	1924	14/4/24	66	12·0	16·3	71·7	,,
R 746	,, ...	Gibbston ..	Lake ..	1923	2/4/24	652	10·9	18·5	70·6	Medium.
R 539	,, ...	Fairlie ..	Mackenzie ..	1923	24/3/24	63	11·4	18·6	70·0	..
R 1210	College Hunters ..	Lincoln ..	Springs ..	1924	3/5/24	66	9·8	15·8	74·4	Very good.
R 538	,, ..	Rangitata ..	Geraldine ..	1923	24/3/24	64	12·0	14·6	73·4	,,
R 744	Tuscan	Pembroke ..	Lake ..	1923	31/3/24	65	8·0	20·1	71·9	Good.
R 542	,, ...	Waitawa ..	Levels ..	1923	27/3/24	62	9·9	19·6	70·5	Medium.
R 748	,, ...	Arrowtown ..	Lake ..	1923	4/4/24	652	8·4	21·4	33·2	..
R 747	,, ...	Crown Terrace	,, ..	1923	3/4/24	652	10·7	21·3	68·0	..
R 745	,, ...	Lake Hayes ..	,, ..	1923	1/4/24	642	10·8	22·1	67·1	..
R 1193	White-straw Tuscan	Ashburton ..	Ashburton ..	1924	10/4/24	652	11·9	12·4	75·7	Very good.
R 726	Ditto (improved)	Seddon ..	Awatere ..	1923	6/5/24	642	11·9	13·6	74·5	,,
R 727	White-straw Tuscan	,, ..	,, ..	1923	6/5/24	62	14·7	12·9	72·4	Good.
R 1208	Solid-straw Tuscan	Rakaia ..	Ashburton ..	1924	2/5/24	632	10·6	17·0	72·4	,,
R 1203	,,	,, ..	,, ..	1924	16/4/24	65	11·2	16·7	72·1	,,
R 825	,,	Cust ..	Rangiora ..	1923	11/3/24	63	11·6	18·3	70·1	Weathered sample.
R 824	,,	,, ..	,, ..	1923	10/3/24	622	10·9	19·8	69·3	Ditto.
R 535	,,	Glenavy ..	Waimate ..	1923	21/3/24	61	12·5	18·3	69·2	..

R 826	Solid straw Tuscan	Hawkins ..	Malvern ..	1923	11/3/24	59	15·2	20·2	64·6	Badly weathered sample.
R 1209	Victor	Horrelville ..	Eyre ..	1924	2/5/24	632	11·9	11·0	77·1	Excellent.
R 543	,, ...	Temuka ..	Geraldine ..	1923	28/3/24	622	9·7	17·3	73·0	Good.
S 16	Yeoman	Marton ..	Rangitikei ..	1924	7/5/24	65	12·3	14·7	73·0	,,
R 1204	,, ...	Lincoln ..	Springs ..	1924	22/4/24	64	9·9	18·1	72·0	,,
R 1205	,, ...	Irwell ..	Ellesmere ..	1924	22/4/24	652	11·0	17·2	71·8	,,
R 541	Dreadnought ..	Studholme ..	Waimate ..	1923	27/3/24	652	7·3	19·8	72·9	,,
R 530	,, ..	Weston ..	Waitaki ..	1923	21/3/24	63	10·2	17·3	72·5	,,
S 17	Major	Marton ..	Rangitikei ..	1924	7/5/24	65	10·7	14·9	74·4	Very good.
R 1195	,, ...	Ashburton ..	Ashburton ..	1924	11/4/24	642	11·2	14·7	74·1	,,

Miscellaneous.

R 1190	Queen Fair ..	Ashburton ..	Ashburton ..	1924	9/4/24	65	9·4	13·8	76·8	Excellent.
R 1207	Hybrid W. ..	Horrelville ..	Eyre ..	1924	1/5/24	62	11·2	13·2	75·6	Very good.
R 1191	Turretfield Eclipse	Ashburton ..	Ashburton ..	1924	9/4/24	63	10·0	14·7	75·3	,,
R 1202	Bordier (College) ..	Lincoln ..	Springs ..	1924	16/4/24	65	10·7	15·3	74·0	,,
R 1192	Marquis	Ashburton ..	Ashburton ..	1924	10/4/24	662	9·9	16·4	73·7	,,
R 1199	Zealand	,, ..	,, ..	1924	15/4/24	67	9·2	17·3	73·5	,,
R 1194	Queen Fan ..	,, ..	,, ..	1924	11/4/24	662	8·8	18·5	72·7	Good.
R 1196	Red Fife ..	,, ..	,, ..	1924	11/4/24	66	9·5	18·6	71·9	,,
R 1206	Snowdrop ..	Horrelville ..	Eyre ..	1924	23/4/24	622	12·5	16·1	71·4	Medium.
R 1197	Comeback ..	Ashburton ..	Ashburton ..	1924	12/4/24	66	9·0	19·8	71·2	,,
R 540	Red Straw ..	Fairlie ..	Mackenzie ..	1923	25/3/24	63	10·4	18·5	71·1	,,
R 737	Burbank's Super ..	Omihi ..	Rangiora ..	1923	31/3/24	642	7·0	23·0	70·0	,,
R 1198	Essex Conqueror ..	Ashburton ..	Ashburton ..	1924	15/4/24	62	10·6	21·2	68·2	

NOTE.—All Ashburton samples were grown at the Ashburton Experimental Farm, and Lincoln samples on the Canterbury Agricultural College farm.

was more or less similarly affected, no importance need be attached to the difficulties experienced in milling, and no note is made of any such defects in the statement of results.

Finally, it seems necessary to mention that the colour of flour obtained in the experimental mill cannot be expected to compare with that of the commercial article. This fact has always been realized in all laboratory testing of wheats, and could hardly be otherwise when one knows that it is necessary in experimental milling to run the materials through to the end in each operation, and afterwards to brush out thoroughly the inside of each compartment as well as the sifting-apparatus. This is necessary to prevent any mixture of one variety with another. The results, however, are still comparative.

NOTES ON THE TABULATED RESULTS.

The samples of Velvet compared favourably with those tested last year. Four ranged from good to very good in the amount of flour obtained, and the remaining two were fair.

The two samples of College Hunters tested both gave very good percentages of flour.

The wheats labelled "Tuscan" were below the average for that variety in the amount of flour which they yielded. Two samples of White-straw Tuscan gave 75·7 per cent. and 74·5 per cent. of flour respectively, which must be considered very good; the other sample of the same variety gave a good yield of 72·4 per cent.

Solid-straw Tuscan did not show up as well as previously, but this is due to three of the samples—R 825, 824, and 826—being weathered and more or less unfit for milling. They were tested, not as representative samples, but in order to ascertain the effect of weathering on the yield and the strength of the resultant flour. The first two samples, R 825 and 824, which were only moderately affected, gave rather poor yields of flour; the third, R 826, gave the very poor amount of 64·6 per cent.

Victor, as usual, gave good percentages of flour, a sample from Horrelville, R 1209, giving the rather remarkable amount of 77·1 per cent.

The three samples of Yeoman each gave good amounts of flour. Two lots of Dreadnought were also good. This variety is said by some millers to be unsuitable for milling; by others it is used in large quantities. This may be due to differences in the variety when grown in different districts, but the samples milled in this Laboratory have behaved quite satisfactorily in the mill, and the resultant flour is generally above the average in strength.

The two samples of Major produced very good yields of flour, and gave no trouble at all in the mill. As will be seen, one of these samples was grown near Marton, Rangitikei County, and the other at the Ashburton Experimental Farm.

The miscellaneous samples were grown mostly in Canterbury. Queen Fair gave the excellent yield of 76·8 per cent. of flour, followed closely by Hybrid W. with 75·6 per cent., and Turretville Eclipse with 75·3 per cent. There is little to choose in this respect between these three samples, but, to maintain a uniform classification of flour-yields, percentages above 76·0 are provisionally classified as excellent, and

those above 73·0 per cent. as very good. Hence Queen Fair, though little better than the next sample, is placed in the former class. Bordier, Marquis, and Zealand all gave very good yields of flour, and Queen Fan and Red Fife were good in this respect. The rest, with the exception of a sample of Essex Conqueror, which was poor, were medium milling samples.

WEIGHT PER BUSHEL.

Contrary to results which have sometimes been obtained elsewhere, no close correlation between weight per bushel and yield of flour was observed in the wheats specified in the tabulation. Only among the Solid-straw Tuscan samples is there any apparent connection, and even here an exception must be made of the first sample, R 1208. With the wheats Victor, Yeoman, Dreadnought, and Major there does appear to be a certain parallel, but because of the small number of each variety examined the relationship is probably more apparent than real. Little connection can be seen between these two properties in the miscellaneous samples. At the same time the calculated weight per bushel should prove an additional factor in estimating the relative values of the different wheats.

SUMMARY.

The samples of Velvet recently tested maintained a good average percentage of flour on milling. Tuscan (1923 harvest) seemed lower than usual in this respect, but only five samples were tested. The average of three samples of White-straw Tuscan was very good. Weathered samples of Solid-straw Tuscan gave low results. The few samples of Victor, Yeoman, Dreadnought, and Major gave from good to very good yields of flour, the amounts obtained being well above the average. The miscellaneous samples, with few exceptions, were very good. The wheats tested this year have as a whole yielded good percentages of flour.

As regards the wheat-growing districts no very apparent differences were observed. Canterbury wheats, of which a number were tested, possessed in a majority of cases good milling-qualities. Several samples received from Awatere and Rangitikei Counties gave in each case good yields of flour. The samples from the Lakes district did not appear to be as good as usual.

The calculated weight per bushel of the samples tested did not appear to be generally correlated with the yield of flour.

Proved Seed.—Strains of seeds of proved yielding-capacity are always worth buying, even though the price may be somewhat above that of ordinary samples. It behoves the progressive farmer to make arrangement for his seeds early, so as to avoid delay at sowing-time.

Cleaning out Drains.—A scythe-blade fitted on a long straight handle is useful for cutting grass and rubbish growing on the sides of open drains on the farm. The work can be done more expeditiously with it than with a hook or the slashers usually used.

GRADING OF EXPORT BUTTER AND CHEESE.

LEADING FACTORY AVERAGES FOR 1923–24.

FOLLOWING the practice initiated last year the Dairy Division has compiled for the *Journal* a list of the leading grading averages of butter and cheese factories throughout the Dominion, covering the official year 1923–24. In the previous year's list (published in the *Journal* for July, 1923) the factories were grouped under their respective district grading-stations. On the present occasion, for more convenient general reference and comparison, they are arranged in one consecutive Dominion list as below. It may be mentioned for the information of readers unconnected with the dairy industry that under the official grading system the points for first-grade butter and cheese run from 88 to 100.

BUTTER-FACTORIES WITH AN AVERAGE GRADE OF 92 POINTS AND OVER FOR YEAR ENDED 31ST MARCH, 1924.

Name of Company.	Registered Number.	Brand.	Average Grade.
			Points.
Maketawa	342	M.D.C.	94·98
Waitaki	812	Waitaki	94·52
Midhirst	110	Rugby	94·47
Bell Block	488	Bell Block	94·44
Mells	764	Mells	94·16
Tarurutangi	728	Champion	94·09
Rata	938	Rata	93·87
Rongotea	8	Rongotea	93·82
Wangaehu	1326	Wangaehu	93·66
Akaroa	1579	Akaroa	93·66
Mangorei	345	Mangorei	93·58
Kaitaia	1298	Kaitaia	93·52
Taihape	1188	Tikapu	93·52
Mangatoki	136	Mangatoki	93·51
Lepperton	49	Lepperton	93·41
Rangitikei	1360	Rangitikei	93·40
Levin	910	Lake	93·40
Shannon	1489	Shannon	93·39
Kiwi	299	Kiwi	93·37
Omata	82	Lily	93·36
Stratford	68	Three Star, Good Luck	93·25
Sefton	28	Sefton	93·14
Rangiwahia	750	Quail	93·13
Whangarei	1720	Kauri	93·11
Eltham	31	Eltham	93·11
Featherston	360	Featherston	93·11
Pio Pio	603	Pio Pio	93·09
Hikurangi	303	Hikurangi	93·09
Overland	197	Overland	93·06
Awahuri	664	Red Rose	93·01
Riverdale	106	Trident	92·99

BUTTER-FACTORIES—*continued.*

Name of Company.	Registered Number.	Brand.	Average Grade.
			Points.
Oruru-Fairburn	1337	Fairy	92·90
Golden Coast	991	Golden Coast	92·88
Avon	963	Avon	92·88
Moa Farmers	341	Inglewood	92·83
Heretaunga	1230	Heretaunga	92·83
Murchison	1888	Airship	92·81
Hawera	346	Federation	92·80
Tai Tapu	175	Tai Tapu	92·78
Aria	1734	Aria	92·77
Ruawai	66	Ruawai	92·77
Maungaturoto	1407	Maungaturoto	92·74
Wairoa	1345	Wairoa	92·73
Whangaroa	658	Whangaroa	92·72
Cheltenham	6	Pakeha	92·72
Kaitieke	1119	Kaitieke	92·71
Tikorangi	102	Shield	92·69
Waitanguru	1154	Golden Gem	92·64
Canterbury Central	55	Fernleaf	92·64
New Zealand (Ngatea)	291	Anchor, &c.	92·62
Waiaruhe	268	Arrow	92·62
Raetihi	717	Raetihi	92·62
Buller Valley	277	Buller	92·61
Bay of Plenty	1399	Bay of Plenty	92·60
New Zealand (Frankton No. 1)	1510	Anchor, &c.	92·59
Canterbury Alpine	792	Pine	92·56
Masterton	1307	Masterton	92·52
Cheddar Valley	611	Cheddar Valley	92·51
Kaikoura	302	K.A.I.	92·50
Caroline	236	Caroline	92·50
Northern Wairoa	1358	Northern Wairoa, &c.	92·49
Waitara	726	Waitara	92·49
Uruti	300	Uruti	92·48
Opotiki	337	Opotiki	92·46
Kaponga	732	Kaponga	92·42
Taieri and Peninsula	54	Taieri and Peninsula	92·38
Kaimata	992	The Oaks	92·37
Meremere	316	Meremere	92·37
North Taranaki	723	Flax	92·34
Rotorua	724	Geyser, &c	92·32
Mount Hutt	284	Mount Hutt	92·31
Taieri and Peninsula	1234	Taieri and Peninsula	92·30
Opunake	884	Opunake	92·29
New Zealand (Waharoa)	293	Anchor, &c.	92·16
Patua	73	Patua	92·16
New Zealand (Otorohanga)	185	Anchor, &c.	92·14
Konini	1203	Konini	92·07
Tarata	631	Tarata	92·05
Cam	168	Cam	92·05
New Zealand (Waihou)	1458	Anchor, &c	92·04
Golden Bay	146	Sovereign	92·02

CHEESE-FACTORIES WITH AN AVERAGE GRADE OF 91 POINTS AND OVER FOR YEAR ENDED 31ST MARCH, 1924.

Name of Company.	Registered Number.	Brand.	Average Grade.
			Points.
Pihama	627	Pihama	92·97
Kakaramea	630	Penguin	92·88
Opouriao	1169	Opouriao	92·69
Te Horo	134	The Allies	92·65
Rimu	1155	Rimu	92·65
Temuka	207	Temuka	92·58
Waianawa	1171	Waianawa	92·58
Little Akaloa	32	Little Akaloa ..	92·44
Omimi	74	Omimi	92·43
Brydone	1821	Brydone	92·39
Edendale	36	Edendale	92·35
Milford	267	Milford	92·31
Ngaire	25	Triumph	92·29
Tuturau	132	Tuturau	92·28
Bell Block	488	Bell Block	92·24
Mosgiel	161	Mosgiel	92·22
Kaimata	992	The Oaks, The Ash ..	92·21
Nireaha	335	Nireaha	92·21
Kiritaki	1521	Premier	92·21
Riverbank	985	Riverbank	92·18
Tamaki	58	Big Ben	92·18
United	1296	Whariti	92·15
Pihama	1111	Pihama	92·11
Kairanga	182	Kairanga	92·11
Maharahara	984	Maharahara	92·10
Kaponga	1694	Kaponga	92·10
Stirling	292	Stirling	92·08
Cambridge	125	Fencourt	92·07
Okato	48	Puniho	92·07
Mangatoki	136	Mangatoki	92·02
Alton	1890	Alton	92·00
Bell Block	71	Dove	91·96
Kaupokonui	1099	Auroa	91·96
Wyndham	59	Wyndham	91·96
Staveley	1719	Staveley	91·95
Mangatoki	1086	Mangatoki	91·94
Ballance	1	Ballance	91·93
T. L. Joll	1727	Maori Chief	91·92
Pembroke	234	Pembroke	91·91
Marima	195	Marima	91·91
Tuna	209	Tuna	91·90
Kakepuku	83	Kakepuku	91·89
Wairewa	471	Wairewa	91·86
New Zealand (Rukuhia) ..	114	Anchor, &c.	91·84
Tariki	1700	Tariki	91·83
Awatuna	1622	Taungatara	91·83
Rapanui	1967	Southern Grove ..	91·82
Tariki	216	Miro	91·79
Rongokokako	280	Rongo	91·79
Tisbury	701	Tisbury	91·78
Thornbury	1581	Thornbury	91·77
Kai Iwi	1309	Kai Iwi	91·76
Milton	1030	Milton	91·76
Kaupokonui	633	Kaupokonui	91·75
Kuku	905	Ohau	91·75
Boggy Burn	703	Boggy Burn	91·74
Pihama	1112	Pihama	91·68
Opouriao	1813	Ruatoki	91·66

CHEESE-FACTORIES—*continued.*

Name of Company.	Registered Number.	Brand.	Average Grade.
			Points.
Cam	168	Cam	91·62
Waikouaiti	18	Waikouaiti	91·62
Toa Toa	817	Toa Toa	91·61
Cape Egmont	632	Cape Egmont	91·61
Wright's Bush	206	Wright's Bush ..	91·61
Hauraki Plains	1900	Hauraki Plains ..	91·60
Mells	764	Mells	91·60
Cambridge	1239	Cambridge	91·59
Royal Oak	693	Royal Oak	91·59
Riverdale	106	Trident	91·58
Island	72	Island	91·58
Whiterig	798	Whiterig	91·57
Kaponga	1696	Rowan	91·55
Otautau	1610	Otautau	91·55
Taratahi	101	Taratahi	91·52
Okato	85	Okato	91·49
Wellington Municipal	202	Rahui	91·49
T. L. Joll	1723	Maori Chief	91·46
Patua	73	Patua	91·45
Pukerau	480	Pukerau	91·44
Woodlands	1485	Woodlands	91·44
Aparima	188	Aparima	91·40
Awatuna	60	Awatuna	91·38
Okato	57	Leith	91·36
Paretai	271	Paretai	91·36
Frankley Road	201	Frankley Road ..	91·35
Mangatoki	1087	Mangatoki	91·35
Kohi	923	Kohi	91·35
Kaupokonui	174	Skeet	91·35
Kaitangata	1648	Kaitangata	91·33
Seaward Downs	702	Seaward Downs ..	91·33
Kaponga	1695	Riverlea	91·32
Cambridge	128	Gricedale	91·30
Mataura	38	Mataura	91·30
New Zealand (Aka Aka) ..	121	Anchor, &c.	91·24
Momona	1010	Allanton	91·24
Tokoroa	255	Tokoroa	91·22
Makowhai	213	Makowhai	91·22
Mata	258	Vale	91·22
Mells	1148	Mells	91·20
Morton Mains	1604	Morton Mains ..	91·20
Lochiel	659	Lochiel	91·19
Henley	1627	Henley	91·18
Mangatoki	256	Mangatoki	91·17
Barry's Bay	401	Barry's Bay	91·15
Cambridge	126	Leamington	91·14
New Zealand (East Tamaki) ..	149	Anchor, &c.	91·11
Bainesse	808	Bainesse	91·11
Awarua	545	Awarua	91·10
Kennington	205	Kennington	91·10
Tamaki	1463	Bell	91·08
Ashburton	81	Ashburton	91·08
Westmere	1621	Westmere	91·05
Oaonui	491	Gem	91·05
Takamatua	33	Takamatua	91·05
Menzies Ferry	623	Menzies Ferry ..	91·05
Manakau	815	Black Swan	91·04
Whenuakura	1237	Whenuakura	91·01

SEASONAL NOTES.

THE FARM.

CROPPING PLANS.

It is always a good policy to plan field-work well ahead, and if plans for the coming season have not been decided upon no time should now be lost. Owing to their liability to insect and fungoid attacks, cruciferous crops (turnips, rape, &c.) should preferably be given new ground. Mangolds also do well on new ground, but if the land is in good heart they may be grown successfully year after year in the same paddock: if the land is cleaned thoroughly during the growing of the first crop the cost of the subsequent crops will be greatly reduced.

Farmers experiencing difficulty in growing turnips should turn their attention to crops from which ensilage may be made. Oats will grow on almost any soil, and if sown in mixture with a legume (either tares or peas) give a well-balanced highly-palatable crop, which can be used for soiling, hay, or ensilage. If sown fairly thickly—say, 2½ bushels of oats and 1 bushel of tares or 1½ bushels of peas—most annual weeds will be smothered out. These crops must be sown early and manured with 2–3 cwt. of superphosphate or other quick-acting manure. The legumes will improve the soil, and time is available after cutting for giving the paddock a short fallow during the dry weather.

WINTER PLOUGHING.

The midwinter months allow of comparatively little in the way of cultivation except ploughing of land for spring-sown cereals, and roots and fodder crops for spring and early summer sowings.

In Canterbury and North Otago if wheat has not been sown by about the middle of June it is as well to postpone the operation until the beginning of August. Where it is intended to break up grassland for spring sowing this operation, under Canterbury conditions, should be done in the winter. The action of frost has a beneficial effect in pulverizing the soil, and the maximum amount of water can enter and is more readily taken up by the subsoil. The latter may be looked upon as a reservoir which feeds the soil as its moisture is evaporated or used up by growing crops.

DRAINAGE.

At this time of year all open drains should be thoroughly cleaned, and drainage operations generally completed. Nothing retards the early growth of pasture and crops in the spring so much as a wet and cold subsoil. Money spent on manures and lime is more or less wasted where drainage is the controlling factor. Low-lying areas on land which is really not in need of complete drainage often

become inundated during a wet winter, and every observer must have realized what decreases in yield are brought about by this cause. Such patches can often be successfully drained by a single furrow.

PASTURES.

Pastures should be harrowed in July to spread manure before the spring grass begins to come away. Where stock have congregated round gateways, haystacks, or shelter-belts it is well worth while carting off the dry manure to poorer parts of the paddock. Young grass on light land will be benefited by rolling; this operation should not, however, be performed on a frosty morning. Top-dressing of pastures, which was dealt with last month, may be continued.

Clover stands being saved for seed should receive a minimum of cultivation in the first year. In the second year an occasional stroke with the light harrows prior to shutting up in August would in many cases prove beneficial. Super may be applied with benefit before the beginning of August to clover stands being saved for seed.

LIMING.

On damp and naturally sour land—particularly in large areas of Otago and Southland—lime should be applied during July and August, so that its beneficial influence may be felt during the ensuing spring. On the heavy raw types of soil ground burnt lime can be most advantageously used, dressings of 15 cwt. per acre generally sufficing. On the lighter soils carbonate of lime finely crushed, applied at about 30 cwt. per acre, is advised. For general purposes 18 cwt. of carbonate of lime is equivalent in calcium to 10 cwt. of burnt lime. It will therefore be appreciated that where carting has to be carried out over long distances burnt lime should be used if possible. The importance of liming in south Otago and Southland cannot be overstressed, and the present comparative cheapness of lime in those districts should be an incentive to the farmers to top-dress a large acreage this winter.

Pasture top-dressing with lime can with advantage be carried out during July. It will result in better pastures, in that one of the main effects of lime is the encouragement of desirable grasses and clovers, and the suppression of undesirable weeds.

WINTER FEEDING OF STOCK.

Every wise farmer will have a run-off handy to his area under turnips, &c., while a good plan also is to have racks made of coarse wire netting supplied with oat straw or hay. Farm stock, like humans, appreciate a mixed diet. Roots are very low in dry matter content, and the dry fodder not only gives the stock more concentrated food but also provides variety. Care should be taken to remove stock during wet weather from roots being fed off on the heavier lands, in order that the texture of the soil may not be spoiled. Neglect in this direction may mean a ruined field for some years.

Any mangolds still in the ground should be pulled or harrowed out at once, so as to give them time to mature further; if they are

left in the ground much longer the tops will start to shoot. If the better-keeping varieties are carefully pulled, the tops removed, and carefully stacked they will keep well into November and in some cases to Christmas. Mangolds may be fed quite safely to breeding-ewes, providing the ewes are brought on to them gradually. The roots should be carted out from the dumps daily. Up to 15 lb. or 20 lb. per sheep per day will be a suitable amount if fed to supplement dry fodder. For cows also receiving hay about 60 lb. of roots is a suitable ration.

In some districts thousand-headed kale and chou moellier is grown for July–August feeding. Care must be taken not to feed these too liberally to newly calved cows, otherwise there is a danger of red-water. If this class of forage is cut and allowed to wilt for a day or two before feeding there is not much danger.

One or more top-dressed and harrowed paddocks should now be selected and shut up for early calving cows and early lambing ewes. There is nothing better for these animals than a nice clean pasture.

—*Fields Division.*

THE ORCHARD.

PRUNING.

During the next two months pruning should be pushed along with all possible speed. Advantage should be taken of all favourable weather in order to complete this important work before growth commences in the spring. If found necessary, pruning operations can continue up to the end of August or even until early September. The main reason for endeavouring to complete this portion of orchard operations earlier is owing to the fact that there are other phases of work, such as spraying and cultivation, that call for immediate attention during August and September.

Gathering up the prunings and burning them should on no account be neglected, even for a single season. This should be done with as little delay as possible after the pruning is completed. Where young trees are being pruned the operator will find that the gathering up of the prunings will be much facilitated if he lays hold with one hand the piece to be cut off, while using the secateurs to cut with the other. Once this habit is acquired one very soon finds that the prunings as they accumulate in the hand can be laid in a heap under the tree ready to be gathered up. Moreover, one can go still further than this by having around his waist a bag or loose piece of scrim, with the other end swung over the neck, in which can be placed the prunings from a number of trees. These can be emptied in heaps at convenient places, which will still further facilitate the gathering-up. Prunings can be easily burned once a small fire has been commenced with some dry material. The ashes should be saved either for using in the orchard or, at a later period, in the vegetable garden. They should be kept dry until required, as if exposed to the rain they quickly loose their manurial value.

One of the sources of disease is the heap of unburnt prunings often left about from year to year. Scale insects, red mite, woolly aphis, and fungoid diseases are almost invariably found on prunings. Another point necessary to stress is the complete eradication (root and branch) of any trees that have died or been cut down owing to silver-blight infection. I have very often seen the stumps of trees remaining in the orchard after the tops have been cut away. The Stereum purpureum organism grows freely on limbs or stumps of this kind (see article by G. H. Cunningham, in *Journal* for May, 1922). From these spores are given off, which may be the cause of a good deal of infection in the orchard and possibly throughout the district.

SPRAYING, ETC.

On some varieties of peaches and nectarines leaf-curl is somewhat difficult to control, and such varieties as Wiggins, Carmen, Paragon, Elberta, and Early Rivers should receive a spraying of pure bluestone (1 lb. to 12 gallons of water) some time early in July, followed later with bordeaux. Further instructions will be given next month.

If San Jose scale is at all in evidence all stone-fruit should be sprayed with lime-sulphur (1 in 12) or red oil (1 in 15).

Much useful work can be accomplished at this season in the control of woolly aphis on apple-trees. When this pest makes its appearance on trees for the first time much can be done to prevent it spreading if the affected parts are painted with red oil diluted with water, using 1 part of oil and 1 part of water. A fairly stiff paint-brush is the best to use, and each infected part should be carefully painted. It is surprising how quickly one can get over a large number of trees in this way, and the colonies which usually winter over on these knotted and distorted places will be entirely destroyed. The best time to do this work is soon after the leaves have fallen and before the application of any spray mixture.

OTHER WORK.

As mentioned last month, planting should only be proceeded with if the land is of a dry nature, and unless good conditions prevail it should be postponed until August.

Where cover-crops have made sufficient growth attention should be given to ploughing them under, but only provided the land is not too wet. It is often more harmful to plough when the land is in a sodden condition than to postpone this work until a later date.

Full advantage should be taken of any broken weather during the winter months of cleaning up and repairing orchard harness, tools, and implements. The spray pump and engine should be given a thorough overhaul, as much valuable time may otherwise be lost during the busy spraying season. Failure to control some of the diseases may also result, and in consequence the material receives the blame.

SHELTER.

In most parts of New Zealand fruit cannot be grown without shelter, and every fruitgrower should make adequate provision in this direction. In certain localities the high winds of last season proved

the necessity for this. Two of the most suitable trees for this purpose are Pinus insignis and Lombardy poplar. They both grow very freely and make ideal shelter, but the poplar is of little value unless the land is rich. On the poorer classes of soil Pinus insignis has proved to be one of the best. If not already planted, shelter-trees should be placed out as soon as weather conditions are suitable.

—L. Paynter, Orchard Instructor, Christchurch.

CITRUS-CULTURE.

This month usually offers a welcome respite to growers in that there is little other work which needs attention than the harvesting of such fruits as may mature from time to time. However, opportunity is afforded for attention to shelter-belts, the trimming of hedges, and any necessary repairs to glass-houses, sheds, implements, &c. Stocks of spraying materials, manures, and other accessories should now be replenished, and spraying outfits overhauled and any renewals made where necessary. Every endeavour should be made to complete the sites for the extension of any citrus areas.

FIREBLIGHT.

It is still necessary to remind orchardists that a sharp lookout should be kept on all pip-fruit trees at this period, with a view of locating any fireblight cankers in areas where the disease is known to have been present. Upon identification the cankers should be entirely removed, as instructed in previous notes. It is quite possible that fireblight hold-over cankers may be present in any pip-fruit orchard, and a thorough inspection of all trees should be made for all such at the earliest opportunity or during pruning-time.

—J. W. Collard, Orchard Instructor, Auckland.

POULTRY-KEEPING.

THE BREEDING-PENS.

A MATTER for first consideration now is the mating-up of the breeding-pens. This is one of the most important phases in the poultryman's year, and a time when his judgment is put to a severe test. Profitable production implies profitable stock, and the securing of this rests chiefly on the class of stock mated. Many poultry-keepers consider that the incubating and brooding stages are of chief importance, but these are only necessary links in the chain of management. The quality of the parents is the chief consideration in successful poultry-keeping. The keen poultryman will carefully study his breeding operations, and will be guided by the sound principles upon which the successful breeding of all stock rest. The ABC of this is that like produces like, and that no stock can be too good to place in the breeding-pen.

In recent issues of the *Journal* advice has been given regarding the type of bird most desirable for the breeding-pen, and too much

importance cannot be attached to this. It should, however, be clearly understood that the most productive hen is not always the best breeder. It is never a wise course to place in the breeding-pen a freak type of bird, however good a layer. For the advancement of a strain it is now realized that it is only the type which has been bred true to a given ideal from generation to generation which has the power to transmit desirable characters. Not only should the breeder be a proved good layer, but it should also possess trueness of breed-type and, above all, maximum points indicative of strong constitutional vigour, such as tight feathering, clean face, prominent eyes, well-developed crop, and an active business-like appearance. Another important qualification in the breeding-hen is that it be a layer of good-sized, marketable eggs. Many breeders are pinning their faith to export trade as a means of unloading the summer surplus, but they will find the critical oversea markets will not pay full rates for undersized eggs. The existing problem of the small egg can only be solved by breeders taking greater care in the selection of their breeding-stock, as well as the eggs intended for incubation purposes.

The male bird has also an important bearing on this matter—he is more than half the flock. He should be the son of a healthy mother with a pedigree of egg-laying performance behind her and a producer of first-grade eggs.

As to size, whether in male or female, one should never breed from diminutive specimens of their breed. The small ones will come soon enough even where good-bodied birds are mated. If a desirable size of stock is to be maintained, all breeding-stock should conform to the weight clauses as contained in the Utility-poultry Standards for the respective breeds. Copies of the Standards are obtainable from the Department at a cost of 3s. each, postage free.

PRODUCTION OF AUTUMN AND WINTER EGGS.

Autumn-produced eggs again reached a high-price level this year, thus indicating that the majority of poultry-keepers have not yet learnt how to produce this what might be termed "out-of-season" luxury. In Wellington during March and April the price gradually rose till eggs were being retailed at about 3s. 8d. per dozen. As a result those poultry-keepers who hatched out a fair number of chickens in July and who managed their plants to the best advantage reaped a good reward. In addition to having a good number of pullets producing at that time they took care that a large proportion of the adult stock were in a laying condition. This condition of the flock was attained by reason of the fact that none but the late moulters—in other words, those birds which gave promise of being long-season layers—were retained on the plant. The early moulters and poor layers had been previously got rid of. Under this method of management, together with the high ruling price for eggs, a good margin of profit over and above the expenses of running the plant was secured.

This is a striking contrast to the returns secured on the great majority of plants at this period of the year, where the eggs gathered

do not even pay for the food consumed. It may be argued that the bulk of July-hatched pullets will moult with the adult stock, and that there will be a loss of winter eggs. It is quite possible that they will, but on a well-managed plant there should be later-hatched pullets specially bred to lay during the cold months of the year. In any case the early-hatched birds will not all moult and cease to lay at exactly the same time. With such birds it will generally be found that eggs, in more or less degree, will be obtained right through the dear season. The reason for this is that while some birds will moult early others will continue to lay, so that when the latter are moulting the former will have renewed their feathers and be ready to resume laying. Then, again, owing to the fact of such birds moulting during the late autumn or early winter they can usually be depended upon to lay well into the autumn during the following year, when the price of eggs is on the up-grade. Generally speaking, the poultry-keeper's most lean period of the year is from, say, the middle of March to the end of May. In most cases the adult stock are then taking their period of rest, while owing to late-hatched birds or through indifferent management the pullets fail to produce when expected. This means that there is much money going out and little coming in. If the maximum results are to be secured sufficient eggs should be collected to at least balance expenses. Just as the successful market-gardener aims at a rotation of crops and has something to sell each month of the year, so must the poultry-keeper be in a similar position if his business is to be really profitable.

After all, there is no great secret in securing a fair supply of autumn or even winter eggs. The right class of stock is available to produce them as well as the knowledge to manage the plant on paying lines. It is thus merely a matter of securing high-tested stock, and knowing how to apply the available knowledge in regard to their management. The latter is the great essential—in other words, it is the human element that counts most. Theory is all very well in its way, but this must go hand in hand with practical experience. The poultryman who secures eggs in the dear season and generally makes a success of his business is usually termed lucky by those who fail. There is no luck about it, for it is nothing more than common-sense management combined with strict attention to details. I have recently received many complaints from people who have tried to secure autumn and winter eggs but have failed in their objective. In most cases the cause is put down to the same old trouble—bad luck—and so it goes on from year to year. There are some people, however, who start on a sound financial footing, understanding something of poultry-keeping, who consistently endeavour to improve their methods and conduct the business in a careful and methodical manner. Somehow they never have bad luck. True, at times they make mistakes, but these are seldom of any moment. They succeed in the things that really matter, and thereby make poultry-keeping the profitable work it is to those who thoroughly understand it and treat it as a serious proposition to be mastered and conducted on the same strict business principles as any other commercial undertaking.

With the many complaints reaching me in regard to pullets failing to lay when they were expected to little mention is made of the conditions surrounding the stock to enable me to arrive at a probable explanation of the difficulty. Rather than content themselves that bad luck alone has been responsible for their disappointments I would advise these and others who have had a similar experience to ask themselves the following questions: When were the pullets hatched—too early or too late? Were they bred from tested winter-laying stock? Were they properly reared? Was the class of food altered too often, or was inferior food purchased because it was cheap? Was old wheat suddenly changed to new wheat - a common cause of poultry moulting? Did the birds receive a regular supply of animal food, so imperative for the production of winter eggs? Were green food and grit always available? Did the birds contract colds and spread them through the flock by reason of a draughty house and failure to find and remove the cause; or was it due to an exposed position and failure to provide shelter? Were the birds and houses infested with vermin? Had the runs been allowed to become poultry-sick, and were the birds infested with intestinal parasites from this cause, or was there any attempt made to rear the pullets on clean ground, so essential for their welfare? Even those questions do not cover the whole field which calls for investigation to account for much of the so-called bad luck. It should never be forgotten that if the birds are well housed, well fed, and properly managed, and yet do not lay well it may be taken for granted that they are a poor-laying strain. The best remedy is to get entirely new blood of a strain noted for egg-laying power.

One little point which may be mentioned in regard to securing early chickens is that in June or July it is seldom that second-year birds are laying, and in order to secure early chickens the poultry-keeper is forced to use pullet eggs for incubation. Of course, the principle of breeding from pullets for the maintenance of a heavy-laying flock, or, in other words, as foundation stock, is on no account recommended; but in the case of breeding pullets especially for the production of autumn eggs an exception must be made. In any case, the pullets bred for this purpose need not necessarily be used as breeding specimens. The use of pullets is not so much objected to, provided they have been bred from an adult hen and commenced to lay early in the year without being forced, and have moulted in the usual way about April or May. Where pullets are to be bred from it is desirable that they be mated with a second-year male. The great danger lies in using pullets in the breeding-pens generation after generation, as the chances are that the stock as well as the eggs they lay will decline in size. Especially is this the case when the pullets have been mated with cockerels bred in the same way.

There is every reason to believe that autumn and winter eggs will be as dear next year as during the present one. Poultry-keepers should therefore look well ahead and prepare now to secure them, remembering at all times that a dozen eggs produced in the autumn and winter months are worth more than two dozen of the spring and summer product.

—F. C. Brown, Chief Poultry Instructor.

THE APIARY.

WINTER WORK.

Spare supers that were left on the hives should now be removed, where it can be done without unduly disturbing the cluster, and the bees confined to the brood-chamber. In the northern parts of the Dominion breeding will start in colonies of normal strength at the latter end of July, and every effort should be made to make the bees snug, so as to promote breeding. Where the bees have taken to the supers entirely the bottom storey is the one to be removed.

During the dormant season mice are likely to make themselves troublesome in the apiary. They attack the stores, and otherwise destroy the combs. Many colonies are by this means reduced to the verge of starvation by the spring. It is the work of only a few minutes to examine the hives, and where gable roofs are adopted the mice-nests will usually be found on top of the mats. To obviate this trouble the entrance should be contracted.

A periodical examination should be made of all extracting combs stored in the honey-house, for the purpose of seeing that they are not attacked by moths. Where the combs have been attacked they should be fumigated. To fumigate place the combs in supers piled one above the other, and put a saucer full of carbon bisulphide on the top. The fumes, being heavier than air, will sink slowly to the bottom, destroying all moths and eggs with which they come in contact. Care should be taken not to inhale any of the fumes, as they are poisonous. The gas being highly inflammable, it should not be brought into contact with a naked light.

MOVING BEES.

The present is the one and only season during which beekeepers should attempt any wholesale shifting of their bees. The bees will be in as nearly dormant a condition as it is possible to find them in our mild climate, and they should be numerically weaker than at any other time of the year. The moving of bees either long or short distances has in each case peculiar difficulties to be overcome. In the former case there is the question of ventilation to be thoroughly considered, and also the matter of making the inside of the hive as immovable as possible. The vibration set up by any mode of transport tends to disturb the cluster, thereby exciting the bees and thus raising the temperature of the hive. When this takes place the bees are in danger of suffocation and the brood of being scalded. The use of wire screens will to a large extent prevent the occurrence of these troubles. Where possible all heavy combs should be removed from the hives, leaving only sufficient honey to keep the bees from starvation during their journey. The vacant spaces should be filled with empty combs, and the frames made as secure as possible by inserting wedges between the tops of the end frames and the walls of the hives. This should prevent the frames from rocking during transit. The bottom board should be secured to the hive-body by means of crate staples, using about six to each hive and driving one end of the

staple into the hive-body and the other into the bottom board. The wire screens—made by using narrow laths nailed together to form a frame of the same dimensions as the top of the hive-body and covered with wire-cloth—should be securely fastened to the top of the hive-body, and more wire-cloth tacked over the entrance to the hive. This last operation should be carried out at night when all the bees are indoors.

The hives should now be quite ready for a long journey. The roofs will, of course, not be needed. In placing the hives in a cart or truck they should be arranged so that ventilation through the wire screens will not be interfered with. If stacked exactly one on top of another the bottom ones will be prevented from obtaining the requisite amount of air. Wooden battens should be placed between each two tiers. Motor transport is, of course, the ideal method of dealing with bees, and where possible the beekeeper should adopt this means.

In moving bees a short distance the difficulty is of quite another nature. Sufficient ventilation is easily obtained by means of wire-cloth tacked over the entrance, and with the bottom boards and covers firmly secured to the hive-body by means of staples the hives should carry without any trouble. Unless, however, the beekeeper chooses his time well he is apt to lose many of his field bees when moving the hives a short distance. The field bees know every landmark within a fair distance of their hives, and in the summer their knowledge must extend over several miles of country. With the approach of shorter days their flight becomes correspondingly shorter, until in the depth of winter it resolves itself into a mere search for exercises. Consequently when a spell of bad weather arrives, and the bees are confined to the hives for days at a time, their familiarity with their surroundings must lessen. Therefore if the beekeeper wants to move the bees a short distance with a minimum of loss he should choose a time when there is a prospect of several wet cold days arriving. By the time the bees are able to take a flight again they will have lost all interest in the old landmarks and be just as ready to adopt the new site as the old. By removing bees a short distance during a spell of fine weather innumerable field bees will be lost through their tendency to return to the old site on leaving the hive. It may be mentioned that a slanting board, if placed in front of the entrance of the hive, will make the bees take more notice of the change of their surroundings than they otherwise would.

PLANS FOR NEXT SEASON.

During the off-season is the best time to make plans for the following season. The beekeeper should decide what increase he desires to to make, and should prepare accordingly. Making up hives and frames is exasperating work if left till the bees are in urgent need of room, and it should be finished long before the actual time for increasing one's stock arrives. The beekeeper should also face the question of providing himself with stocks of foundation, and make arrangements for the treatment of his surplus wax by some neighbouring maker of foundation. He should also decide on which market to place his crop, and lay his plans accordingly. It is advisable, too, that he consider the theoretical side of his occupation, and study, while

the bees are in a dormant condition, the best methods of improving his stocks. Neither weather conditions, locality, nor any other factor will influence the honey-crop so much as strong colonies of bees, and the apiarist should endeavour, while he has the time, to ensure that these shall be in existence during the coming summer.

—*E. A. Earp, Senior Apiary Instructor.*

THE GARDEN.

VEGETABLE-CULTURE.

NEW season's operations in the vegetable garden commence with the month of July, and the grower who desires to be successful will take the opportunities as soon as they arrive. As soon as the land can be got into condition plant early potatoes, artichokes, shallots, cabbage, and cauliflower plants, herbs, garlic, and autumn-sown onions. Sow peas, main-crop onions, and a small quantity of carrots, lettuce, radish, and parsley. Autumn-sown peas, and spring cabbage and lettuce planted out towards the end of March should be cleaned up, and, as soon as growth commences, receive a little manure to push them along.

This matter of manuring is most important and yet most difficult to write about, as the circumstances differ in every case. It is a point on which every grower must take a special study. A useful dressing just before sowing is 1½ oz. each of superphosphate and bone-dust, also ¾ oz. of sulphate of potash, per square yard. To liven up young plants inclined to lag ½ oz. to ¾ oz. of nitrate of soda or sulphate of ammonia per square yard is useful; it can be applied at intervals of a fortnight or so. It is also useful for keeping plants in bearing. The gardener may remember that 1 oz. to the square yard equals 2½ cwt. to the acre.

At the present time the asparagas beds should be cleaned up and an application of wood-ashes applied, followed by a good dressing of half-rotted manure. If this is not available apply 4 oz. of blood-and-bone and 1 oz. sulphate of potash per square yard.

When the ground is finally prepared for onion-seed it is most desirable to make an application of soot—sufficient to colour the ground; it has qualities specially helpful to this crop.

SMALL-FRUITS.

The planting of small-fruits—raspberries, strawberries, currants, and gooseberries—should be completed now as soon as the weather permits. Each of the shrubby kinds will need careful pruning as soon as planted. Raspberry-canes should be cut down to within 6 in. of the ground. Black currants will require the main growths to be cut back hard to induce vigorous growth. Red currants will need a little more discriminate cutting, so that suitable terminal buds are selected to fork the branches and form the desirable cup-shaped arrangement of leaders. Gooseberries will require a somewhat similar treatment.

Established plants also will require careful pruning and generous manuring if good crops are to be maintained. Heavily thin the twigs on

gooseberry-bushes, cutting back old wood and weak wood to within a bud or two of the base, and leaving only strong new shoots evenly distributed over the branches which form the framework of the plant. Black currants too often make poor growth through lack of pruning and manures. As the crop is borne chiefly on the young wood, the older growth should be cut well back to induce a strong growth of the fruit-bearing wood. Red and white currants, on the other hand, require gentler treatment once the bushes are set, as the fruit is borne on laterals and spurs, which will require a little thinning and shortening occasionally to keep them sufficiently vigorous for cropping. Raspberries will also require their usual winter pruning.

Contrary to the general practice, all such small fruits should now receive a thorough dressing of a well-made bordeaux mixture of winter strength. If this is followed by a good dressing of manure—three parts superphosphate and one part each of sulphate of ammonia and sulphate of potash—say, at the rate of 2 oz. to the square yard, good though shallow cultivation, satisfactory results may be expected.

FLOWERS AND LAWNS.

Flower borders and shrubberies may now be cleaned up. It is usual after clearing away all dry sticks and litter to skim-dig them. This is work requiring great care, and should be done only by some one who knows the details of the planting. This is an excellent opportunity of working in such manures as may be required—organic manures or lime, bonedust or superphosphate. In a state of nature herbaceous plants in any quantity do not remain in one place, but gradually creep to new soil. In the garden this has to be met by artificial feeding and replanting every few years, if best results are to be obtained.

Excellent crops of that pleasing winter-flowering plant the anemone may be obtained from seed planted now on a piece of well-prepared light land in a sunny position. They will flower next winter.

The work of trimming hedges and pruning trees and shrubs should be completed. It is best to defer rose-pruning till the danger of hard frosts is over.

Lawns in a mossy, poor condition will be much improved if they are now well raked up and some seed sown before top-dressing them with $\frac{1}{4}$ in. to $\frac{1}{2}$ in. of good fresh loam to which has been added a fourth part of powdered lime.

—W. C. Hyde, Horticulturist.

Goats for controlling Blackberry.—A correspondent writes asking whether any *Journal* readers can inform him where in or near Auckland goats can be procured with the object of controlling blackberry. Any information addressed care of the Editor will be forwarded.

Feeding off Roots.—Where roots are being fed off, the breaks should not be made too large. An area to last the stock for a week or ten days is quite large enough.

Shelter for Farm Stock.—Hedges and tree shelter-belts are a profitable investment. This is the planting-season.

ANSWERS TO INQUIRIES.

IN order to ensure reply to questions, correspondents must give their name and address, not necessarily for publication, but as a guarantee of good faith Letters should be addressed to the Editor.

COWS SLIPPING THEIR CALVES.

"TUSSOCK," Reporoa :—

Several of our cows have slipped their calves while grazing on young grass and soft turnips. They only had from one and a half to two hours on the green feed each morning, and were then turned on to old pasture. Would the turnip-tops be likely to cause trouble under the circumstances? The cows were from three to four months off calving.

The Live-stock Division :—

While it is possible for the feed you describe to produce bloating, which condition occasionally causes a cow to slip her calf, it would be safer to take the precautions necessary for dealing with contagious abortion. The aborted cows should be immediately isolated in a paddock by themselves for a period of from four to six weeks. They should be washed out daily for the first week, with a solution made by dissolving one teaspoonful of permanganate of potash in a gallon of water, and later every second or third day, until all discharge has ceased. Aborted cows should not be put to the bull for at least two months.

BLUESTONE TREATMENT FOR FOOT-ROT IN SHEEP.

"ROMNEY," Takaka :—

Please inform me at what strength to use bluestone when dealing with foot-rot in sheep; what amount of bluestone one should dissolve in one gallon of water; and what time the sheep should be allowed to stand in the trough.

The Live-stock Division :—

Where a large number of sheep are affected the foot-bath method of treatment is recommended. For mild cases 3 oz. of bluestone to the gallon of water should be sufficient. More serious affections can be treated with a strength up to ½ lb. to the gallon. Before treatment care should be taken that all loose and diseased parts are removed from the animals' feet.

REMOVING PEAR-TREES.

C. I. BARTON, Raetihi :—

I have a couple of pear-trees about fifteen years old and in full bearing, which I wish to move to a new position about half a mile distant. Kindly tell me if this can be done with safety to the trees, and how I should go about it.

The Horticulture Division :—

Under normal conditions there should be nothing to prevent the successful removal of the pear-trees as long as labour and power are available. Commence by pruning the trees hard, thinning laterals and leaders where possible, and shortening back to wood-buds those that are left. Next dig a trench round the tree at a distance of a yard or so from its base and sufficiently deep to get below the main roots, when the tree should be undermined and all downward roots cut. Then by steadily rocking the tree and filling the hole it can be raised to the ground level, when, if the tree is laid over on its side, it can be rolled on to a sledge and removed. If left at any time during removal the roots should be covered with damp sacks; in fact, during transit it is best to have the roots lashed up in damp sacking. A hole of ample size should be prepared for reception of the tree, carefully gauging its depth. The tree may then be laid over on its side and carefully rolled in, and the sacks removed. Fill in the hole and tamp the surrounding space. Before completing the filling it is best to give a good soaking with water.

RATSTAIL IN PASTURES.

"SUBSCRIBER," Opotiki :—

Kindly inform me whether it is possible to eradicate ratstail-grass by any other means than by ploughing.

The Fields Division :—

In some districts, notably parts of North Auckland, ratstail where it is predominant in a pasture is successfully burnt. To do this it is necessary to have plenty of growth, even if it means leaving the paddock unstocked all winter. The grass is fired in September, and then sown with a mixture of clovers, Lotus major, and grasses, together with 3 cwt. or 4 cwt. of basic super or super and slag. The idea is to get the new grass away well ahead of the ratstail. The area should be heavily stocked the following season. Where the ratstail is scattered, cutting early for hay (before seeding) and top-dressing immediately afterwards will tend to check it. Otherwise there is nothing for it but ploughing and summer cultivation. We presume you are on the flat, and the Opotiki flats are far too good for ratstail. Crops of maize or mangolds well intercultivated would help you.

LAW AS TO RABBIT-PROOFING A BOUNDARY-FENCE.

M. B. S. YEOMANS, Karioi :—

Kindly advise me if it is legally compulsory to pay half the expense of rabbit-proofing a boundary-fence.

The Live-stock Division :—

The Fencing Act, 1908, has been amended by the Fencing Amendment Act, 1922, and the law now provides that where a dispute as to liability to contribute towards the erection of a rabbit-proof fence or the conversion of a non-rabbit-proof fence into a rabbit-proof fence has been taken before the Magistrate's Court to determine, the Magistrate, when hearing the case, shall take into consideration the condition of the rabbit pest in the district and the possibility of the land occupied by the person giving the notice becoming infested with rabbits from the adjoining land. If the Magistrate should decide that the receiver of the notice be not required to contribute the half-cost of the fence, the giver of the notice may convert the fence at his own cost, and may at any time remove the wire netting from the fence and deal with it as his own property. After the wire netting has been erected on a fence to convert it into a rabbit-proof fence, the adjoining owner (the receiver of the notice), even though he has not been called upon to pay half-cost of the conversion of the fence, shall nevertheless be liable to bear the half-cost of repairing such fence as a rabbit-proof fence until the wire netting is removed.

LINSEED FOR HORSES.

"SUBSCRIBER," Ashburton :—

Will you kindly advise me as to the value of linseed for keeping horses in health ; also proper method of using it, and amount that may be used ?

The Live-stock Division :—

Linseed is a highly nitrogenous and fatty food, but its carbohydrate matter is small. It is therefore an unbalanced ration, and should be fed with other mixtures such as oats, bran, and chaff. Healthy horses do not require it, but as a diet for sick animals it is very valuable on account of its nutritious properties. For horses out of condition it is a useful addition to the diet if used in small quantities, certainly not exceeding 1 lb. per horse per day. The best method of preparing linseed is by prolonged boiling, by which a jelly-like mass is obtained.

NOTES.—An unsigned letter, making inquiries regarding lucerne, has been received from a correspondent at Kumeu. As a visit to the farm is desirable in this case before advising, he should communicate with the Instructor in Agriculture, Department of Agriculture, Auckland. "Learner," Murchison, should forward his name to the Editor.

WEATHER RECORDS: MAY, 1924.

Dominion Meteorological Office.

GENERAL SUMMARY.

RAINFALL records for May show great excess, especially in the northern and east-coast districts of the North Island. The South Island returns present less diversity, although the total is considerably below the average for the month in South Canterbury, while it is in excess in North Canterbury and in Otago—being 34 per cent. above at Dunedin and 28 per cent. at Invercargill.

Two cyclonic disturbances passed in the North on the 3rd and 17th respectively. The centre of the former travelled northward of the Bay of Plenty, apparently from the direction of the Kermadec Islands, while the latter, coming from the north-west, traversed the northern districts. While the centre was in the vicinity of Awanui, the officer in charge of the wireless station observed and corrected the reading of the standard barometer, which showed a minimum of 28·50 in. It had fallen from 30·43 in. on the 13th, and recovered to 30·05 in. on the 19th. Little change in atmospheric pressure followed over the Dominion until the end of the month, but on the 25th a remarkable storm of heavy rain and fierce easterly gales visited the northern and east-coast districts of the North Island. Although the barometer was high and did not move more than $\frac{2}{10}$ in. during the storm, it is evident that it was the edge of a cyclonic area operating northward of the Dominion, and a remarkable oscillation of pressure was reported from the Chatham Islands, where barometric pressure reached 30·69 in. on the 26th. This occurrence is one of the most noticeable meteorological events recorded in this country for a long time. Three westerly disturbances of moderate intensity passed in the South, culminating on the 1st, 10th, and 31st.

Temperatures were mild, and the skies more cloudy than usual, but the local differences make further brief generalization impossible.

—D. C. Bates, Director.

RAINFALL FOR MAY, 1924, AT REPRESENTATIVE STATIONS.

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average May Rainfall.
North Island.				
	Inches.		Inches.	Inches.
Kaitaia	20·68	21	5·80	5·06
Russell	9·74	17	2·48	3·53
Whangarei	14·41	17	4·75	6·59
Auckland	10·64	22	3·60	4·41
Hamilton	8·34	25	2·21	4·41
Kawhia	7·96	23	1·72	4·77
New Plymouth	6·91	23	1·45	6·16
Inglewood	10·23	23	1·83	9·82
Whangamomona	5·92	20	1·16	6·59
Tairua, Thames	14·94	16	3·00	6·11
Tauranga	7·08	20	1·95	4·88
Maraehako Station, Opotiki ..	11·42	15	4·40	4·82
Gisborne	13·58	18	2·43	5·50
Taupo	6·62	16	1·76	3·60
Napier	4·80	17	1·92	4·14
Maraekakaho Station, Hastings ..	5·12	19	1·40	3·52
Taihape	3·36	23	1·12	3·75
Masterton	4·23	18	0·66	3·91
Patea	6·15	19	1·10	3·91
Wanganui	2·96	9	0·66	3·40
Foxton	1·98	9	0·56	2·32
Wellington	3·65	15	1·23	4·73

RAINFALL FOR MAY, 1924—*continued.*

Station.	Total Fall.	Number of Wet Days.	Maximum Fall.	Average May Rainfall.
South Island.				
	Inches.		Inches.	Inches.
Westport	7·06	21	0·90	6·58
Greymouth	9·51	20	1·10	8·39
Hokitika	9·38	20	1·26	9·79
Arthur's Pass	6·33	11	1·78	10·93
Okuru, Westland	11.30	11	2.00	11·60
Collingwood	10·90	18	3.02	10·18
Nelson	3·13	14	0·90	3·13
Spring Creek, Blenheim ..	2·07	9	0·85	2·49
Tophouse	7·50	15	2·23	5·46
Hanmer Springs	2·40	17	0·72	3·52
Highfield, Waiau	2·48	11	0·70	2·76
Gore Bay	4·14	14	1·67	3·43
Christchurch	4·79	19	1·09	2·56
Timaru	1·72	18	0·72	1·27
Lambrook Station, Fairlie ..	0·94	8	0·26	1·28
Benmore Station, Omarama ..	0·91	13	0·22	1·75
Oamaru	..	..	..	1·58
Queenstown	1·31	11	0·51	2·71
Clyde	0·69	8	0·20	0·97
Dunedin	4·29	18	0·60	3·20
Gore	3·25	16	0·82	2·84
Invercargill	5·84	20	1·26	4·55

INTRODUCTION OF BEES, HONEY, AND APPLIANCES.

THE regulations governing the introduction of bees, honey, and related appliances into New Zealand, under the Apiaries Amendment Act, 1913, gazetted on 7th October, 1920, have been revoked and replaced by the following :—

1. In these regulations " appliance " means any hive, frame, comb-foundation, or other thing used in connection with the keeping of bees and the harvesting of their products.

2. The introduction of bees into New Zealand is prohibited, save with the precedent consent of the Minister of Agriculture.

3. Each application for authority to import bees must be made in writing, and must state the name and address of the breeder, and the location of the apiary from which it is proposed to secure such bees.

4. No appliance which has been used in connection with bees shall be introduced into New Zealand : Provided that in connection with bees imported with the consent of the Minister of Agriculture there may be introduced such used appliances as are necessary to serve as containers for such bees.

The new regulations were gazetted and came into force on 5th June current.

PRICE OF STRYCHNINE AND PHOSPHORUS.

OWING to a fall in wholesale values the Department has been able to reduce the price of those materials retailed by it for rabbit-destruction, as follows : Strychnine, reduced from 6s. to 4s. 6d. per ounce (including container and postage) ; phosphorus, reduced from 4s. 6d. to 3s. 6d. per pound. The new prices date as from 16th May in the case of strychnine, and from 1st June for phosphorus.

REVIEW.

"THE CULTIVATION OF NEW ZEALAND PLANTS."*

In this little book Dr. L. Cockayne appeals to the highest and purest sentiment—the love of nature. It has been aptly said that in order to grow plants one must love them. The distinguished author is evidently an excellent gardener, for his love of plants stands out in bold relief on every printed page. Within the compass of 139 pages he has condensed the description of some eight hundred New Zealand species which may be grown in gardens for study and delight. This has been accomplished by the adoption in the technical parts of a truncated wording and terse elliptical phrasing easy to follow, the volume being so compact that it slips into the pocket as easily as half a dozen letters for the post. The claims of New Zealand plants to a place in every garden are urged, and the neglect which is so frequently their portion in their native country is lamented. Throughout the author strikes a high patriotic note and demands that New-Zealanders shall take more interest in their own unique plants. "They had their origin in this land of ours; it is they which have given the peculiar stamp to its scenery. And of what high quality are they! Is there any tree in the world quite the equal of the lordly kauri? What other flowers surpass those of the kowhai, the pohutakawa, or the white clematis?"

Sections of the book deal with the history of the cultivation of New Zealand plants, how to procure them, and how to grow them successfully; different chapters are devoted to trees, shrubs, and herbs; a whole one is given to that fascinating group the veronicas, a specially remarkable feature of our flora; one to the culture of ferns in the open garden; one to plants for decorating the home; another to school-grounds and children's gardens; and, finally, one to town gardening. At the end is an appendix showing the different purposes to which New Zealand plants may be put, arranged in classes according to the treatment necessary to ensure success in growing them. A good index completes the volume, and there are a number of photographic illustrations. In regard to the printing, by a happy use of capitals and italics the scientific names are easily picked out, and there can be no doubt as to which species is being referred to. The book is an intensely original one in conception and execution. "Excellence consists of trifles, but itself is no trifle"; and in this little book one can detect the influence of the controlling mind accustomed to marshal facts in orderly arrangement and to supervise their presentment to the smallest detail.

It is to be hoped that Dr. Cockayne's enthusiasm will not be in vain, and that the cultivation of New Zealand plants will be greatly stimulated by this publication. With regard to the overseas demand for New Zealand plants, it may be pointed out that New Zealand nurserymen who elect to cater for this market should take pains to supply plants true to name and properly packed. Catalogues published with the botanical names frequently misspelt are not calculated to inspire the possible purchaser with confidence in the nurseryman's knowledge of his business or his capacity to supply the plants asked for.

The reviewer would draw attention to the great need there is for the publication of a cheap and portable book of illustrations to the New Zealand flora, similar to that issued as an accompanying volume to Hooker and Bentham's "Handbook of the British Flora," a small volume which contains 1,315 accurate figures of different species. Mr. Esmond Atkinson's clever drawings show what might be done in this way in New Zealand.

The book is obviously written for the general gardener. In future editions it would perhaps be desirable to somewhat enlarge the scope of the work, introducing chapters dealing with New Zealand plants suitable for special kinds of gardening, such as bog, water, and rock gardens, and the growing of the handsome epiphytes or perching-plants. A little might be said of New Zealand indigenous vegetables and fruits. *Tetragonia trigyna and T. expansa* are useful as spinach, the latter being used the world over, and porporo-pudding is reputed to be delectable. It may also be suggested that the author should add a chapter on New Zealand scented plants, placing at the top that peerless *Olearia fragrantissima*, whose odour is sweetest of any.

* "The Cultivation of New Zealand Plants," by L. Cockayne, Ph.D., F.L.S., F.N.Z. Inst., F.R.S. New Zealand Practical Handbooks Series. Whitcombe and Tombs (Limited)., 1924. Price 4s. 6d.